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THE

JOURNAL OF SCIENCE.

MARCH, 1883.

I. THE BRAIN THEORY OF MIND AND MATTER.*

By CONSTANCE ARDEN.

"The Vedic poets dimly recognised their Gods as only symbols of the ultimate power that manifests itself in the world,—the Atman or Self—the Self of all things—the Self in which each individual must find rest."—MAX MÜLLER, *India, What can it teach us?*

IT is not seemly that an artist who has painted any part of a picture, even though his share be confined to the back-ground or the accessory figures, should present himself as a critic of the completed work, nor that one member of a Beaumont and Fletcher partnership should undertake to point out the merits and defects of a jointly-written drama. Yet, if the picture or the play deals with some forgotten legend, or shadows forth some unfamiliar truth, nothing can be more natural than that its meaning should be clearly and publicly set forth by one of its fashioners. What is permissible in the field of art may become imperative in the region of scientific verity, where the substance of the work is everything, and the style nothing, save as a more or less efficient vehicle for the conveyance of ideas to the understanding. I need therefore not apologise for this brief exposition of the main thesis contained in a *brochure* to which I am one of the contributors.

* What is Religion? a Vindication of Free Thought, by C. N. Annotated by ROBERT LEWINS, M.D. With an Appendix on Hylo-Idealism; or, the Brain Theory of Mind and Matter, the Creed of Physics, Physic, and Philosophy. London: W. Stewart and Co., 41, Farringdon Street, E.C.

The standpoint of Hylo-Idealism cannot be wholly unknown to readers of this Journal, since from time to time letters and articles on the subject, by Dr. Lewins and myself, have appeared in its pages, some of which are reprinted in the tractate before me. At the base of the whole philosophy lies one fact adumbrated by many,* realised by few, but contradicted by none; for those who attempt to disprove it invariably mistake the object of attack, and manfully hew away at the shadow of the tree, while its roots still strike deeply into the earth, and its trunk and branches tower and wave above these would-be assailants. No one has ever been able to deny, though many have fancied that they were denying and confuting, the proposition that Man is the maker of his own Cosmos, and that all his perceptions—even those which seem to represent solid, extended, and external objects—have a merely subjective existence, bounded by the limits moulded by the character and conditions of his sentient being. It is admitted by all whose opinion is of any value that colour exists only in relation to the eye, sound to the ear, touch to the skin, odour to the nose, and taste to the mouth. Nor has anyone yet asserted that (in the case of man and of the higher animals, our data not enabling us to deal with possibilities of sensation in lower forms of life) these elementary feelings can be generated in the absence of a percipient brain, which focuses converging rays of sense from all parts of the body, and unites them into the white light of consciousness. But the most rigorous analysis can extract from the "external" world nothing save colour and form, sound which developes into music or degenerates into discord, tastes, and odours, with harmonies and dissonances of their own, and impressions of touch, whence arise those ideas of solidity and extension which to the unreflecting seem conclusive proofs that the Universe must at least possess tangible objective reality, even though its visible, odorous, and sapid complement be but a brain-created panorama. In these days of physiological research and of popular scientific instruction it should be clear to any person who takes the slightest trouble to think about the matter that the phenomena of all the senses possess

* Such adumbration may be remarked even in the writings of so staunch a religionist as Cardinal Newman. In a passage from the "Grammar of Assent," quoted in the current No. of the "Westminster Review," he says, "Everyone who reasons is his own centre, and no expedient for attaining a common measure of truth can reverse this truth." Again, "There is no ultimate test of truth besides the testimony borne to truth by the mind itself." The Reviewer well observes that the Cardinal's theory is indistinguishable from that of Protagoras.

precisely the same degree of validity, and that this validity is purely internal and individual. "The whole universe of things and thought is thus only an *automorphosis*, each Ego being to itself, as Protagoras postulated, the measure and standard of all existing things, of all thought and objects of thought whatsoever." * The profound Protagorean maxim is frequently attacked, with complete misapprehension of its import, by philosophers and scientists of the shallower sort, who appear to suppose that it implies an ignorant disdain of all existence which is not human, instead of a recognition of the solidarity between Man and the Universe, animate and inanimate, sentient and senseless.† A more than usually amusing example of this misconception is afforded by that popular writer Grant Allen, in a recent work reviewed last month in the "Journal of Science." It is evident, from his patronising approval of wind-fertilised flowers, and his vehement attack upon the poppy, the convolvulus, and the "unlovely" *Gloxinia*, that if the mind of man in general cannot claim to be the "measure of all things," yet the mind of Mr. Grant Allen in particular conceives itself well entitled to that proud pre-eminence.

Let us see in what sense every man is, to himself, the standard by which "all thought and objects of thought" must be tested and classified. A colour-blind person has perceptions which are quite as true as those of the most subtly discriminative landscape painter; but the retinal "colour-box" of the former has no tints corresponding with the green and crimson which the latter differentiates into a thousand delicate gradations. The unknown force which we call Light, and picture intellectually as a series of ethereal vibrations, without thereby advancing a step towards the knowledge of its essential nature, acts impartially upon the retina of both. That its internal manifestations are diverse depends upon the special organisation of the two individuals. One has, and the other has not, colours in himself. Light, then, is not a simple gift from the sun, but is a product of mental metabolism, which fashions all that we know of brightness and darkness. Beyond this there is practically nothing, for our wildest imagination cannot overleap the boundaries of Self, and depict an invisible cause of Light. The very terms which we must use, if we wish to imply

* What is Religion? p. 38. Appendix No. 1.

† Even J. S. Mill, who in his definition of Matter as a "permanent possibility of sensation" virtually adopts the Auto-centric position, inconsistently condemns the axiom of Protagoras as "a scandal to philosophers," evidently quite misapprehending its real import.

that such a thing is possible, demonstrate by their contradiction its impossibility. But supposing for a moment that this inconceivable power could be gained, its possessor would probably perceive nothing which could distinguish the origin of light from the origin of sound or odour. It is well known that one and the same cause, such as an electric shock or abnormal distension of the capillaries, will produce different effects in the various organs of sense. The eye may see flashes of lightning; the ear may hear the sound of a gong; the skin may feel acute pain; or rather the brain may transmute identical stimuli, conveyed to it by different channels, into results which are not only dissimilar, but actually have nothing in common. Since the dissimilarity does not come from without, it must come from within; therefore we arrive at the conclusion that the world is made inside, and not outside, the cerebrum. Although rejecting that Absolute Idealism which will deny the existence of aught that is corporeal, even of the sensifacient hemispheres and the sensiferous nerves, we are forced to accept that Relative Idealism which declares that the only Cosmos known to man, or in any way concerning him, is manufactured in his own brain-cells. Far more truly than the painter "creates" the picture from elaborated materials already provided for him by "Nature," every one of us creates Nature herself, in a tiny cerebral studio, without pencil and without pigment. We make the mountains, and the sea, and the sun himself; for sunshine is nothing if not visible, and if there were no eye and no brain there could be no sunshine.

These truths are so self-evident that it seems superfluous to quote authorities in their support. It may, however, not be altogether useless to refer my readers to the recent translation of Kant's "Critique of Pure Reason," by Professor Max Müller, and also to a very able though not perfectly consistent article on the great German philosopher in the current number of the "Edinburgh Review." The following sentences from the latter are especially applicable:—"Kant's whole system throughout is nothing but the question underlying all philosophy, and which Hume had made clear as day, in language for ever intelligible to all educated minds—the question, namely, whether we can really know things or only thoughts, whether our knowledge is objective or only subjective. It cuts up by the roots for ever, when understood, the empirical pretensions which have again imposed on so many minds in our time." Again—"Kant answers the problem, How is Science possible? or, as he elsewhere puts it, How are objects or

judgments of experience or synthetic judgments *à priori* possible? thus: 'The only way this can be done is to recognise from the first that thought and things are not diverse or dualistic. The one does not exist apart from the other. Objects are not passively apprehended by the mind as something distinct from it, *but are actively constructed by it.*'" *

As I have already stated, the Absolute Idealism of Fichte and Hegel is by no means adopted by the authors of this treatise. They consider, with David Hume himself, that the real existence of Matter can be denied only by a metaphysical quibble, which carries no conviction to any sane mind. Matter, so far from being a nonentity, is the *fons et origo* of all entities. In this connection, two of the annotations appended by Dr. Lewins, may profitably be studied. "It must be steadily kept in mind—a fact too apt in discussion to be lost sight of—that Hylo-Idealism, which deals alone with the relative, ignoring the absolute as utterly beyond human *gnosis*, in no sense denies the objective, but only contends for *identity* of object and subject, proved as it is by natural Realism itself, from the doctrine of *molecular metamorphosis*, which shows the Ego continually undergoing transubstantiation with the Non-Ego, and *vice versâ*, so as to form *one* indivisible organism."† Again—"I have always striven to render intelligible the significance of Hylo-Idealism by the following illustration:—Our bodies and the so-called external universe,—*i.e.*, the Ego and Non-Ego, or, in other words, Subject and Object,—resemble a porous vessel of ice, filled with water, immersed in an infinite ocean. What is within and without, and the septum that seems to divide the two, are all three consubstantial or identical, and, owing to the porosity, always interchanging particles. So that, in reality, the seeming three are, like the mystic Athanasian Trinity, virtually one, and essentially indivisible. It is thus a distinction without real difference to speak of division between substances homogeneous and

* One remark that, "with all his originality, Kant *never* disengaged himself from much of the traditional nonsense of philosophy," is susceptible of a far wider and deeper application than that intended by the Edinburgh reviewer. Kant started back in terror from the obvious consequences of his own principles, and endeavoured to rebuild in the "Critique of Practical Reason" what the "Critique of Pure Reason" had pulled down. The persistently dualistic character of his thought is well illustrated by his famous confession of the awe inspired by *two* things,—the order of the starry heavens and the moral law in the human mind. A consistent Monist must have felt that these "two" are essentially one.

† Page 48.

virtually *solidaire.*"* Thus it is seen that man is distinct from his environment only as a cell may be said to be distinct from the matrix, or intercellular matter, which forms its home, and supplies it with nutriment. Take, for example, a cartilage cell. It lies in the midst of a territory of its own, homogeneous with itself in origin, essential structure, and chemical composition. Through this domain run a series of branching canals, by which nutritive fluids may pass to the centre. These fluids, again, are composed of the same elements as the physiological unit whose vitality they help to support, and are derived from the blood, which bathes and permeates every tissue just as the "external" environment bathes and permeates the body as a whole. Between man and the cell a very instructive parallel may be drawn. In one sense a unit, in another a complex, organism; in one sense separate from surrounding matter, in another most intimately fused and blended with it; in one sense a permanent individual, in another losing identity, by change of form and material, from day to day, from hour to hour, from moment to moment,—all this must be said of man, and all this of the animal or vegetable cell. Life, in every case, is correlated with those natural forces from which it springs, and to which it returns; or, more correctly speaking, life is due to the co-operation of all the Protean forms of material energy, which, as in azoic Nature, work automatically, and require no "spirit" to accelerate or control their activity. The phenomena of voluntary motion and individual character no more testify to the presence of an immaterial Archaeus than does the spontaneous and distinctive action of a chemical reagent. Add solution of caustic soda or potash to mercuric chloride, and a bright yellow precipitate is thrown down, while a bright blue mass results from a like experiment with soda and cupric sulphate. Here, as in human thought and deed, the activity proceeds, not from external compulsion, but from internal constitution. Objective conditions, as temperature, atmospheric pressure, &c., may be the same in both experiments, but, to speak in terms of human personality, the subjective character of the compounds tested is dissimilar, and their behaviour corresponds with this inherent heterogeneity. No doubt the laws which determine the conduct of a sentient being are far more complicated than those which govern chemical union and decomposition. But this is just what might have been expected from *a priori* considerations. The animal organism receives,

* Page 26.

assimilates, and finally breaks up and parts with a thousand complex and unstable chemical compounds; but these are only its raw materials, which are mingled in varying proportions in every microscopic fragment of the body. Minute cells are built up whose very nuclei contain an intricate network of almost inconceivably delicate fibrils. These cells are again combined into tissues adapted to the performance of their several functions, and these tissues are in their turn moulded and interwoven to form the different organs of this wonderful Microcosm. Finally, all the organs are subordinated to the rule of two sovereigns, acting with complete concert—the cerebro-spinal and the sympathetic nervous system. When we learn that a single nerve trunk is composed of hundreds of fibres, varying from 1-14,000th to 1-2000th of an inch in diameter, that each of these fibres probably transmits its own special message from periphery to centre, or from centre to periphery, and that every message exerts some influence upon the thoughts and doings of man, we need not marvel that his ways are often incalculable, and his cogitations past finding out. To regard the intellect as an entity, separable from the myriad factors which unite to produce and to direct it, is not less absurd than to consider as actual beings those personified abstractions which we meet with in poetic diction,—to believe, *e.g.*, that Gray beheld in a literal "vale of years" the "painful family of Death, more hideous than their queen," or that Milton's Satan ever conversed with Sin and Death at the gate of Hell. The following note by Dr. Lewins well elucidates my meaning:—"In medicine symptoms are the synonyms for phenomena. They can always be traced to their source in an organ, and are intensified, diminished, modified, or removed by acting on the organ. In no case can they be isolated and dealt with *per se*."* Now, the aggregate of cerebral functions or phenomena, which we call Mind, no more constitutes a separate entity than does the aggregate of abnormal symptoms, which we call Insanity.

Facts and inductions like these are evidently fitted to revolutionise, not only our manner of regarding the physical Universe, but also our habits of thought and action with respect to all the higher problems of mind and of practical life. New and great ideas, if duly assimilated, must modify our views of all which was previously known or imagined, and many a cherished illusion must fall when the "Autocentric" or "Hylo-Ideal" theory is finally establised. The

* What is Religion? p. 40.

world of sense is a picture, a poem, a melody. Granted; but what, then, shall we say of the world of intellect and emotion? Is this the more real of the two, or is it merely a vision of the painting, a reminiscence of the lyric, an echo of the music? The answer is not far to seek. We believe that Matter is the ultimate reality beyond which it is impossible to penetrate, and that its most elementary, most general, and most easily verified manifestations are found in simple physical and psychical phenomena. From combinations of these phenomena, all our conceptions must be exclusively drawn, and by similar combinations they must be corroborated or disproved. All ideas, notions, or fantasies, are of course equally subjective, since none can boast an origin higher than the human brain; but some may be in harmony, and others in open discord, with the observed course of nature, while a third group may stand apart from facts altogether, assuming a position neither of amity nor of enmity. The two latter classes are alike illegitimate, the one being false, and the other simply irrelevant. A proposition which can neither be denied nor affirmed is for all practical purposes rejected, for, in reason, as in law: "*De non apparentibus et non existentibus eadem est ratio.*" No one can prove by induction or deduction that witches never ride on broomsticks through the air, or cast malignant spells over children and cattle; that fairies have never danced by moonlight on the green, or that the Lorelei never sat singing on her dark rock, and luring unwary travellers to destruction; yet all these fictions have imperceptibly passed away from popular belief, to a limbo prepared for dogmas and legends not less unscientific, but hitherto more tenacious of life and power. It is time that the pseudo-science of Ontology should be superseded by Physiology and Psychology, and that the vain search for final causes, to which all religion may be referred, should be renounced by those whom reason must teach to behold in the orderly arrangements of the Cosmos only a supreme glorification of Matter, the Universal Mother, and of Man, her child. In the grey cells of the cerebral cortex are generated, not only the visible Heaven, "this majestical roof, fretted with golden fire," but the poetic sense of its beauty and harmony, and even the conditions of time and space which correspond to the revolution of its spheres. For, without the intellect, time and space, infinitude and eternity, which are at present abstract concepts formed by the brain, would, so far as we know, be annihilated. Matter would still, as in geologic and pre-geologic ages, continue its immortal existence; but matter,

untouched, unseen, unperceived by sensation or thought, must be a void and formless chaos, until the first living eye gives it shape and colour, the first living organ of touch endows it with tangible solidity, the first living ear wakes the dumb to speech and song.

II. THE CONSTITUTION OF THE SUN.

By R. LAMONT.

IN a former paper ("Journal of Science" for October) I tried to prove shortly that sunlight had an electric origin; in fact that the sun might be likened to the core of a huge dynamo-machine, and the outer matter belonging to our system to so many field-magnets, and that, owing to the revolution of the latter round the former, the attraction which existed between them was continually being broken, and that the breaking of such attraction resulted in a continual flow of luminous electric currents between the sun and planetary matter. I propose now to investigate the constitution of the sun with the view of further proving the probable truth of these speculations.

When viewed through a powerful telescope the sun does not present the same uniform brilliancy over his whole surface which we see when we look at him with the unaided eye. He is seen to be made up of luminous masses irregularly interspersed throughout a less luminous background, while on both sides of his equatorial belt are seen irregular black spots which emit little or no light. These spots, which consist of a dark central portion, or *umbra*, gradually blend into the brighter portions of the sun, where they are generally surrounded by very brilliant streaks of light or *faculæ*.

During a total eclipse the sun's atmosphere is seen to contain strange cloud-like masses or *red-flame prominences*, some of which appear detached from him, while others appear as if they formed part of his surface. Surrounding the entire surface, and reaching far out into space, the *corona* is seen as a bright halo of silver-white light.

With the exception of some minor details, the foregoing are nearly all the facts that have been gleaned with the aid of the telescope alone; but when combined with the spectroscope there is still a vast field to explore.

As it is beyond the scope of this paper to go into the details of spectrum analysis, I will take it for granted that the reader is already familiar with the subject, and merely state a few general principles bearing on solar phenomena.

Sunlight, as seen through a spectroscope, presents the appearance of a rainbow-tinted band, interspersed with numerous *black lines* which have been termed, from the name of their discoverer, Frauenhofer lines. These lines invariably occupy the same place in the solar spectrum, maintaining their respective distances one from another, whether the light be received direct from the sun or reflected from the moon, planets, or other opaque bodies.

An incandescent solid or liquid, when looked at through a spectroscope, gives a continuous spectrum free from black lines; but if the solid or liquid body be heated until it is in the state of a glowing vapour, the continuous spectrum will disappear, and be replaced by a series of *bright lines*, each vapour having its characteristic lines as to colour and position, so that we can at once infer to which particular element the spectrum belongs.

An incandescent body shining through a vapour gives a continuous spectrum, interspersed with black lines corresponding to the bright lines which the vapour would have given alone.

The spectrum of light reflected from an opaque body depends on the nature of the medium surrounding the reflector. If the light has to pass through a vapour before reaching the opaque body, the black lines corresponding to the vapour will be intensified, and if the reflector is self-luminous the spectrum belonging to it will be superadded to that of the reflected light.

The spectrum of any element may vary according to the conditions of temperature and pressure under which it gives out its light.

With these facts for our guidance we may now proceed to the actual examination, the first question which presents itself being—Is the body of the sun composed of the same elements as our earth, and, if so, are these bodies for the most part in a solid, liquid, or gaseous condition?

When the spectra of a number of different terrestrial elements are compared with the solar spectrum, it is found that

the bright lines belonging to several of these elements exactly correspond with the position of certain black lines in the solar spectrum. From these coincidences Kirchhoff concluded that those elements which gave spectra consisting of bright lines corresponding with solar black lines must not only form part of the body of the sun, but enter into the composition of his atmosphere. He reasoned—"There is a solid or a liquid something in the sun, giving a continuous spectrum, and around this there are vapours of sodium, of iron, of calcium, of chromium, of barium, of magnesium, of nickel, of copper, of strontium, of cobalt, and of aluminium; all these are existing in an atmosphere, and are stopping out the sun's light. If the sun were not there, and if these things were observed in an incandescent state, we should get bright lines from them."

"Such, then, is Kirchhoff's theory of the sun. There is a something—Kirchhoff said it was a liquid—which gives us a continuous spectrum, and between our eye and that incandescent liquid surface there is an enormous atmosphere, built up of vapours of sodium, iron, and so on; and the reason that we get the dark lines is that the molecules of the substances named absorb certain rays, those, namely, which they produce when they are in an incandescent state." *

Now if this inference of Kirchhoff's, that the sun contains the same elements as the earth, be correct, it follows that if they are the same in one respect—namely, in that of emitting the same kind of light—it is almost certain that they are the same in every other respect, and that the elements which go to form the sun obey the same chemical and physical laws as these elements would do at the earth's surface.

If we accept this elementary sameness as a fact, and wish to explain solar phenomenon on a fiery basis, then since iron, calcium, and magnesium are invariably found in the spectrum of the sun's atmosphere, and since these bodies cannot be rendered gaseous without first passing through the liquid condition, we must infer that, if not the whole, at least the surface of the sun is in a molten state. And this molten mass must consist either of layers of the elements arranged according to their densities, or of a homogeneous mixture formed in accordance with the laws of liquid diffusion. And the gaseous envelope surrounding the sun must also be diffused or stratified in the same manner.

* Lockyer's Solar Physics.

Now what kind of spectrum would such a constitution give? It would very probably give the solar spectrum line for line and band for band, but it would give the same spectrum over all its parts. This as a matter of fact is not the case, as we find the umbra of a spot to vary from its penumbra, faculæ to be distinguishable from the adjoining surface, and the sun's atmosphere itself to give an ever-varying spectrum. If to fit this changing spectra we assume the sun to consist of a *solid body* surrounded by *glowing vapours*, we will, at the same time, require to endow solar elements with properties differing widely from our own. In fact we at once require to resign the only certain ground that we have to work upon, and return to the doubts and difficulties of a bygone age.

Everywhere throughout Nature we find simplicity and uniformity,—a solid changing to a liquid, and a liquid to a gas. But nowhere do we find gaseous iron, calcium, or magnesium suspended over solid sodium, nickel, or zinc. As long as our predecessors tried to explain planetary motion by their intricate cycles and epicycles, so long did they fail; but the moment they applied the laws governing the motion of terrestrial matter all became simple, and their hitherto erratic hosts were seen to obey the same laws as the matter strewn around them. We know that the attraction which binds sun, planet, and system together is everywhere the same, whether it be engaged in building up the atoms of a chemical compound or holding together the constituents of a universe. Are we to accept this as an infallible law, not only when applied to force, but when compared with matter, the progenitor of force, and to hold that wherever matter is found there will we find it endowed with the same properties as terrestrial matter? If we do this, and accept of the coincidence of the Frauenhofer lines as a sure index that the sun is made up of elements exactly the same as our own, then we require to find a new explanation for the phenomena taking place at the surface of the sun.

As already mentioned, the sun, when seen through a powerful telescope, is no longer the bright unblemished mirror which our forefathers had pictured in their minds, but is seen to be a coarse-grained unpretentious-looking body, with its full complement of corrugations, pores, and granules, and its bright faculæ as it were to light the way to the deep profundities of its vast willow-leaf strewn caverns.

What do we know about these cavities? Are they really vast cavernous depths reaching far below the surface-clouds hanging in a transparent atmosphere,—scoriæ floating on a

molten mass,—rifts in the sun's mantle, through which his *dark surface* is seen? or, lastly, is the sun a world like our own, consisting not only of the same elements, but of land, river, and sea; and are the dark spots which we see but the sun's huge *oceans* partly laid bare by the rolling back of his cloudy covering? And are our red-flame prominences but watery vapour, at one time wafted along by the gentle breeze, at another riven and torn by the furious hurricane? And are our pores, granules, and luminous masses but the appearances which result when a series of electric discharges take place from a mixed conductor, obscured by a semi-transparent envelope?

In the electric spark we have heat, light, and chemical rays nearly—if not exactly—the same as those we receive from the sun. While the spark is capable of volatilising our most refractory substances, it does not appreciably *heat* the body from which the spark is drawn. But if it *meets with resistance* in its passage from one body to another, then heat is generated in proportion to the resistance encountered.

Now suppose the sun were constituted exactly like our own earth, with its green fields, mountains, seas, atmosphere, and clouds, and all the phenomena pertaining thereto; and, further, that electric sparks were issuing from every part of its surface capable of producing a spark. How would this supposition compare with what we know about the sun?

From our knowledge of electricity it is almost certain that, owing to varying conduction, the solid parts would emit light, varying in quality and intensity according to the composition of the matter from which the light emanated, and that *the liquid parts would emit little or no light.* If such a conductor were viewed without the intervention of any obscuring agent, this unequal luminosity would be distinctly seen even at great distances. But if obscured by an atmosphere more or less saturated with aqueous vapour, then, owing to refraction and reflection, the light would be seen to be nearly equally dispersed over the whole surface, and no inequality would be observed unless when condensation of the vapour took place at one part more than another.

That such local condensation does take place we have positive proof, from the fact that the sun's atmosphere is seen to contain cloud-like masses, which, when examined by the spectroscope, give a strong indication of their being principally made up of hydrogen gas, an element which invariably results from the decomposition of aqueous vapour by the electric current.

If we were merely searching for an analogy between solar and terrestrial phenomena, we might point to the sun's undoubted solidity and revolution on his axis,—his similarity of composition,—his atmosphere and clouds,—his aërial currents and cyclones,—the correspondence of his spot belts with our sub-tropical zones,—and last, though by no means least, *the correspondence of these belts with the situation of our own oceans.*

But analogy alone is no proof. We require more than mere resemblance. His atmosphere and clouds, though like in appearance, might differ greatly in composition from our own; his aërial currents might bear the breath of the fiery furnace; and his oceans, though occupying the same relative positions, and stirred by the same forces, might be very different from the simple compound of oxygen and hydrogen with which we are acquainted. Still, we cannot get away from the fact that where there is a somewhat complete analogy there is probably a more intimate connection. But, be that as it may, it is from the correspondence of the spot-zones with the position of the greater bulk of the waters of our oceans that we mean to draw our chief argument.

Sir Wm. Herschel supposed the sun to be a non-luminous body surrounded by a luminous atmosphere, and sun-spots to be rifts in that envelope through which his dark body was seen. We, on the other hand, suppose the solid or earthy parts to be luminous, and the liquid parts to be nearly non-luminous, so that if a rift took place in his clouds over a solid part we would see that part more luminous than its surroundings; but if the opening took place immediately over water, then it would be seen as a comparatively dark spot, bright at the edges from reflection, and more or less shaded towards the centre, according to the height above the surface of the water at which the rift took place.

That such appearances would result from an arrangement of this kind can be easily demonstrated as follows:—Stretch a piece of white paper over the mouth of a glass funnel blackened inside to exclude outside light, and make an opening of about half an inch in diameter in the centre of the paper. Then fix the funnel mouth downwards at a short distance over water contained in a vessel with blackened bottom, and a little less in diameter than the funnel. Here, the paper represents the sun's envelope; the aperture, a sun-spot; the water, the liquid part of his surface; light from the outside, rays emanating from his solid parts; and an eye placed at the opening in the neck of the funnel, an observer at the earth's surface. On looking through the

neck of the funnel towards the opening, the general surface of the paper appears more or less illuminated according to its transparency, while the borders of the aperture are more brightly illuminated and are surrounded on the inner side by what at first sight appears to be a halo terminating in a dark central portion, but which, on further examination, is found to be a reduced image of the opening reflected from the water to the eye. In fact, with a small tuft of cotton-wool over the aperture, and a pan with irregular bottom underneath, it is possible to produce all the appearance peculiar to sun-spots.

From these appearances alone we might be able to find an explanation for spot phenomena, but fortunately in this case we do not require to depend altogether on appearances, as from the indefatigable labours of our spectroscopists we learn that spot spectra are not the same as spectra from any other parts of the sun's surface, but show signs of increased absorption, the point of greatest absorption being at the centre, and decreasing therefrom towards the edges.

Now, if our supposition that spots are openings in the sun's clouds over water be correct, it follows that all rays of light travelling from the shores of the oceans, or from the waters of the oceans, over which we suppose visible spots are formed, will require to cross each other before they can pass through these openings, and that the points of maximum crossing will be at or near the centres, and that the points of minimum crossing will be at the edges of the openings. Let us compare this *optical fact* with what we know about spot spectra. The point, in our hypothetical spot, where the greatest number of rays cross is at the centre, exactly corresponding to the part where we find the greatest absorption in sun-spots. The point of least crossing is at the edges, where we find little or no increased absorption in sun-spots. Again, the lines that show by far the greatest absorption in sun-spots are those belonging to sodium and hydrogen. What does this fact point to? Is it to the emanation of an excess of the *feeble* monochromatic light of sodium and hydrogen from the oceans beneath? and are we to infer therefrom that directly beneath the spots there is not only water, but sea-water, the same as which is laving our own shores?

This latter question contains much more than it would at first appear to indicate. It is not a question merely as to the presence of an excess of sodium or hydrogen light, but also, first, as to whether or not the presence of metallic vapours in the sun's atmosphere is necessary in order to

explain the appearance of their absorption lines in the solar spectrum; and secondly, as to whether or not the preponderance of one kind of light produces increased absorption of that light.

From spectroscopic observation we learn that while the spectra of the sun's chromosphere and prominences are made up of a few permanent *bright lines*, there are others which seem to appear and disappear, as if their presence depended on the locality under examination. Are we to draw from this the inference that the sun's gaseous envelope has not a uniform composition, but that while a few of its elements—among which we must class hydrogen—obey the laws of gaseous diffusion, there are others which do not, owing to their being possessed of some unaccountable property that allows them to be present with, while yet not diffused through, their more obedient companions? Or might we not reason from these facts that the constant bright lines indicate an atmosphere as uniform and simple as our own, and that the presence of the hydrogen lines points to that atmosphere as being impregnated with aqueous vapour? And, further, that the fleeting bright lines do not belong to gaseous matter in the sun's atmosphere, but to his discontinuous light reflected to us from his clouds? Lockyer ("Solar Physics"), in describing a prominence, says—"Judge of my surprise and delight when, upon sweeping along the spectrum, I found hundreds of the Frauenhofer lines beautifully bright at the base of the prominence." This is exactly where they should appear if they are to be explained by reflection from the surface underneath.

If the fleeting bright lines do not belong to the sun's atmosphere, then the solid body of the sun does not give a continuous spectrum, as supposed by Kirchhoff, but spectra varying according to the composition of the matter from which the light is emanating. Neither is it probable that the Frauenhofer lines are due to absorption in a metallic gaseous medium, but more probably to a mere crossing of the same kind of light rays, as is indicated by the point of maximum crossing in our hypothetical spot, corresponding with the observed point of maximum absorption in sunspots.

There is still another point in connection with our spot hypothesis that requires investigation, namely, the sheaf-like rays of light seen to proceed from the sun during total eclipse. On the hypothesis of incandescent solid and glowing vapour, how are we to explain this clubbing together (if

we may use the term) of light rays? Is it on the assumption of unequal luminosity of the solid body of the sun? If so, then, how are we to account for the irregular direction of the rays? If we were to assume refraction to be the cause, we would immediately be met by the fact that rays evidently emanating from almost the same parts of his surface appear to be oppositely affected, the one group streaming out to the right, while the other goes to the left. Besides, even supposing such was not the case, we cannot but imagine that a medium, sufficiently dense to refract light so far off its natural course, would have a tendency to reduce its intensity to that of the light emanating from the less luminous parts of the surface. On the hypothesis of the sun's being a luminous body enveloped in clouds, if the cloudy covering were all of the same density, and the solid of equal luminosity, there would be uniform radiant light; but if the solid were not uniformly luminous, and there were breaks in the cloudy covering, then the unequal radiant light would be seen to be overlapped or crossed by bright sheafs or streaks of light, proceeding from the openings, the direction of such streaks depending on the positions of the openings as regards the points of emanation of the light. But whatever direction these rays of light originally took, if our theory be correct, they would eventually have to return to a direction in a line with the plane of the ecliptic, which probably accounts for their generally curved appearance.

Next, with regard to solar heat, are we still to hold to our fiery theories, and see the sun as a gaseous or molten mass, the heat of which is maintained by condensation, friction, chemical action, or the impact of other bodies; or are we to account for his heat from one of our most stable laws, namely, that *when force is retarded by matter, heat results?* If we do so, then the force which we receive from the sun, call it what we will, must be retarded in its passage through the sun's atmosphere; therefore heat must result. Part of this heat will be reflected back to his surface, and part *probably* escape into interstellar space. Of this latter part (if any) we will receive our share. But would this be sufficient to account for all the heat that we receive at the earth's surface? I think not; but I do think that it is here that the economy of Nature steps in. His heat is of no use in interstellar space,—it is the worlds circling round him to which it is necessary; consequently these worlds are provided with a gaseous envelope like his own, which retards

his force in its passage through them, thus producing the heat so necessary for the support of animal and vegetable life exactly at the point where it is required.

III. COMING SHADOWS: AN ETHNOLOGICAL STUDY.

By E. S.

THERE is little pleasure in foretelling evil, and especially in pointing out the illusory character of any hopes that may have been entertained by friends, neighbours, and countrymen. Sometimes, however, so to act becomes a painful duty. In speculating upon the future condition of humanity authors and orators have given a brilliant forecast of the progress of the "Anglo-Saxon" race. The correctness of the term here used I will not discuss, since no one can pretend to misconstrue its meaning. The outlook has latterly become more dazzling than ever since the two great branches into which that race is divided have laid aside much of the mutual jealousies which they entertained during the earlier half of the present century. Accordingly we have been told that by the year 2000 A.D. this race would in fact dominate the globe. One great English-speaking community would occupy Australia and the islands of the Pacific; another, seated in South Africa, would gradually overspread the table-lands and mountain-ranges of the "dark continent." Whether these two communities remained members of a British Empire, or became independent Republics, the result would, for the world at large, remain substantially the same.

In the Western Hemisphere the case was even less doubtful. The Great Republic, it was said, would gradually overspread the whole of the continent, and the English tongue would alone be spoken from the confines of the Polar Ocean to Tierra del Fuego. Here, also, it was argued that mere political changes could little affect the main issue. The Republic might break up into two or more distinct bodies, or might even adopt monarchical institutions, but

it would all the same remain a vast "Anglo-Saxon" community. It was calculated—and doubtless correctly—that by the end of the next century the population of the United States would exceed 500 millions. It was shown what must be the influence and the power of such a nation, wealthy, intelligent, energetic, and inventive. Nor have writers forgotten to lay due weight upon the assimilative power of this race. The Frenchman, the German, the Spaniard, even the Irishman, are all incorporated, and, losing their distinctive peculiarities, are fused up into the American.

The future thus limned was one to which neither American nor Englishman could look forward without a thrill of pride. But one element in the calculation has been overlooked. There can be very little doubt but that the population of the United States will, by the year 2000 A.D., have reached, and even overstepped, the full tale of 500 millions. But of what will it consist? Of those whom we call Americans, substantially our kinsmen, though more or less crossed with German, French, or Spanish blood? We fear not. There is, indeed, no occasion to take into account the aborigines, or Red-skins, misnamed Indians. Their doom is evidently in part extinction and in part absorption,—the latter to a greater extent than is commonly supposed.

Nor is the Chinese immigration, even if not forcibly suppressed, to be here taken into account. The Chinese, however undesirable their appearance in America may be on other grounds, are not there in the character of true settlers. They come and obtain work; they amass money with the hope of returning later in life to the Central Flowery Land. They do not bring up families upon American soil, or in any way seek to cast in their lot with their white neighbours. They follow the example of certain aliens in England, who, if temporarily among us and yielding a passive submission to our laws, are not of us.

The factor hitherto disregarded in estimating the future of America is the negro race. It is well known that the first settlers in America, to whatsoever European nation belonging, committed the serious mistake of importing negroes from Africa as slaves. It is not yet known to what an extent they have, by so doing, compromised the future of their remote descendants. Nor must it be for a moment supposed that the emancipation of the negro from slavery and his admission to the rights of citizenship have at all removed the difficulty. Here was the mistake of the Abolitionists. So long, of course, as slavery was recognised in the United States, neither its defenders nor its denouncers,

as a body, saw what the future might have in store. A few clear-headed men, indeed, advocated the removal of the negro element in mass—their re-shipment to West Africa; but they were denounced by the one party as covert Abolitionists, and the other accused them of inhumanity. Above all, the rate of increase of the negro population was totally unsuspected. Men comforted themselves with the imaginary ethnological law that a lower race, placed in contact with a higher, tends, in some mysterious manner, to decline, and ultimately passes away. This supposed law is founded upon a very imperfect generalisation. It held good in the case of the North American "Indians." It holds good with the aborigines of Australia, and even with the Maoris. It does not hold good with the African blacks, who—like mice, rats, house-flies, &c.—seem to multiply more rapidly when brought in contact with civilisation than when left to themselves.

At the time of the forcible emancipation of the negro slaves in the American Union they numbered, it is supposed, about four millions. For the decade 1860 to 1870 the census gives no very trustworthy results. The disturbance arising from the long civil war, and the very imperfect manner in which the population of the Slave States had previously been enumerated, combined to render estimates of negro increase during that term of years open to question. But the census of 1880 showed an alarming result,—alarming not merely to Americans, but to us in England. It proved that the emancipated negro population was increasing at the rate of $3\frac{1}{2}$ per cent per annum, and was consequently doubling itself every twenty years. The white population for the whole of the United States, on the contrary, was found to be increasing at the rate of 2 per cent per annum only, doubling itself, therefore, every thirty-five years. Hence it may easily be calculated that, if these respective rates of increase continue, the blacks must outnumber the whites. Prof. E. W. Gilliam ("Popular Science Monthly"), from whom I borrow the numerical results already given, states that in the United States, taken as a whole, the whites will in 1985 number 336 millions, whilst the blacks in 1980 will amount to 192 millions, and will about double the number of the whites in the Southern States. Consequently in 2000 the blacks will reach 384 millions, and in 2020 actually 768 millions. In the same year the number of whites will be only 672 millions. Hence by that year the blacks will have a clear majority of 100 millions, and will be virtually the sovereigns of the United States. The Anglo-Saxon Republic will have become substantially a Negro Republic, and every decade will more

and more confirm that character. The black, by the sheer force of his fecundity, will outweigh the superior intellect and energy of the white!

How can such a calamity to America, and to the whole world, be averted? A fusion of the two races Prof. Gilliam —rightly in my opinion—pronounces impossible. He writes:—"Account for it as we may, the antipathy is a palpable fact which no one fails to recognise,—an antipathy not less strong among Northern than among the Southern whites. However the former may, on the score of matters political, profess themselves special friends to the blacks, the question of social intermarriage and social equality, when brought to practical test, they will not touch with the end of the little finger. Whether it be that the blacks, because of their former condition of servitude, are regarded as a permanently degraded class,—whether it be that the whites, from their historic eminence, are possessed with a consciousness of superiority which spurns alliance,—the fact that fusion is impossible no one in his senses can deny." I fully admit this conclusion, but I should seek the cause in a simple racial repugnance, founded not on what has been, but on what is and must be. An eminent German professor whose views have been expounded in the "Journal of Science" would doubtless here point to the specific odour of the black, which to the senses of the white is intensely offensive. Under ordinary circumstances no Aryan man would seek a negress as a wife, whilst the notion of an Aryan woman becoming the wife of a negro seems simply revolting. It is noteworthy that since the emancipation the production of half-breeds—one of the worst results of slavery—has decreased, if it has not come to an end altogether. The probability of a fusion of the two races may be in fine dismissed, and it will appear at the same time that the blacks must remain as that dangerous phenomenon an *imperium in imperio*.

It may be asked, Is there any hope that the more rapid increase of the Negro as compared with the Aryan depends upon temporary conditions, which it might be hoped may not be permanent?

Prof. Gilliam maintains that the key to the different rate of increase is found in the superior fecundity of the blacks as a race, "and is strengthened for them—1. As being the labouring class; 2. As labouring under favourable climatic conditions; *i.e.*, living in a semi-tropical region." The second of these conditions evidently applies to the Southern States only. In the Middle and Northern States the negro

must encounter fluctuations of climate and a winter cold very different from those which prevail in the cradle of his race.

But there is one point in favour of the blacks—or rather in disfavour of the whites—which Prof. Gilliam has overlooked: judging from the medical papers, means for the limitation of a family are adopted in the Northern States, as in France. It has been shown, and is indeed self-evident, that Malthusianism, if practised by any one class or nation, means self-effacement. To be efficacious it would have to be universal. That it will not be adopted by the Negro race is certain.

As to the alleged greater fecundity of the blacks, not in virtue of their race, but as a labouring class, some doubt may exist. In France the so-called working population—or, to use the happier expression of Prof. Owen, the "wage class"—is not remarkable for rapid increase. It is said, jokingly of course, but not without a basis of truth, that the *ouvrier* never becomes a grandfather. In England the clergy, who are certainly not taken from the lower orders, have often been denounced by Malthusian writers for their large families. Royalty itself has incurred the same censure. Perhaps, before finally pronouncing that the increase of the Negro is, by a natural law, more rapid than that of the Aryan, it may be well to await the result of at least another census, that of 1890. Whether practicable precautions should not at once be taken is a question not for the ethnologist, but for the politician, and is consequently unfit for discussion in these pages.

Meantime it must be admitted that there is danger not merely in the ultimate numerical predominance of the blacks, but in their very presence as a free alien body placed by artificial devices on a political level with a superior race. In the Southern States of America, after the collapse of the Confederacy, their conduct was marked by such outrages that "bull-dozing" was but a natural reprisal. In the British West Indies they have shown their gratitude for emancipation by insolence and rebellion.

As regards Nicaragua Mr. Belt writes:—"In Central America there never were many black slaves; since the States threw off the yoke of Spain there have been none; and this comparative scarcity of the Negro element makes these countries much more pleasant and safer to dwell in than the West Indies, where it is much larger. The Indian seldom or never molests the whites, except in retaliation for some great injury; whilst among the free Negroes robbery,

violence, and murder need no other incentives than their own evil passions and lust." * What will be the condition of the United States when, if ever, this race has the power to elect judges, governors, and legislative bodies, needs no description. That the Aryan race will submit is impossible, and the consequence must be, I fear, a civil war far more bloody than the last, because a war not of parties, but of races.

Prof. Gilliam predicts grievous results from the co-existence of two incompatible races, but, as it seems to me, on questionable grounds. He writes:—"If the blood of the black population cannot commingle with that of the whites [and he has himself shown that this is impossible] social advancement ceases at an early stage; the higher social planes are incapable of attainment, whereby is broken a fundamental social law that allows the individual full freedom to rise or fall in the social scale without hindrance from race prejudice or prestige." Here the author misstates the issue: the obstacle to the rise of the Negro is not "race prejudice or prestige," but racial inferiority. The "fundamental social law" of which he speaks can hold good only within the boundaries of a race. I admit that an average Aryan, be he American, Englishman, Irishman, Frenchman, or German, is the equal of any other average Aryan, and may claim equal scope. I admit that the individual Negro is the equal of another individual average Negro, but I cannot admit that the average Negro is the equal of the average Aryan. If politicians, economists, ethicists, or the like, place him on an artificial equality, they are the law-breakers, and must be held answerable for the consequences. What the blacks can do when set free, and allowed to take the reins into their own hands, may be seen in Haiti, where now for nearly a century they have played at empires and republics—a laughable farce did it not involve the ruin and waste of a lovely and fertile island.

Prof. Gilliam continues, still overlooking the innate heterogeneity and disparity of the two races:—"That is the healthiest society which is the freest, which gives the fullest play to individual intelligence and energy; and in such a social state we note a tendency on the part of the rich upper class to sink, and the poor labouring class to rise." The relation of the white to the black is not, as I must here again remark, that of the rich to the poor. It is to be here also noted that the Professor seems to conceive of an upper

* Naturalist in Nicaragua, p. 64.

and a lower class only as rich and poor, forgetting that intelligence and refinement are not necessarily functions of wealth. He proceeds:—"The causes [of this slow change of places] are apparent. The sons of the rich eat daintily, exercise daintily, keep late hours for resting and rising, are self-indulgent and extravagant. There are, of course, exceptions. Undoubtedly, however, the surroundings of the sons of wealth create tendencies this way toward effeminacy of body and uneconomical habits of mind. The poor, on the other hand, are compelled, by their conditions of life, to strength-giving exercise and careful saving methods in the management of means. Robust bodies and thrifty ways give upward tendencies, which, acting through the social cycle, lift the descendants of the poor to the higher planes."

Even within one and the same race this picture, I maintain, is overdrawn. The "sons of the rich," in England at least, are given to athletic open-air pursuits, at school, at college, and in after-life. The English squire and the German junker show small marks of effeminacy, and are generally superior in stature to the labourers on their estates. On the other hand, the employments of the poor, save in agriculture, can rarely be called "strength-giving exercise." It would be easy to enumerate a score of trades, including most departments of textile manufactures, pottery, tailoring, shoemaking, steel-grinding, working with lead in any of its forms, and almost all the retail branches of distributive industry, which are positively debilitating and life-shortening. In many cases work is begun at too early an age, before the muscles and the joints are sufficiently matured,—consequently the whole frame is more or less crippled. Unwholesome food, ill-drained and over-crowded houses also prevent the development of robust bodies among the poor. As for thrift it is quite as rare among the poor as among the upper ten thousand. One of the most difficult lessons which philanthropists have to instil into the wage-class is the economical management of means.

I should hence argue that the danger to be apprehended in America is not due to any breach of a social law, but to a couple of blunders, the first and gravest being the introduction of the blacks into the Western Hemisphere at all, and the second their investiture in the United States with the privileges of citizenship.

In South Africa the British Empire meets with the same difficulty, though on a smaller scale. The various black tribes, instead of fading away at the approach of the white man, multiply more rapidly under the British flag, so that

the opening for an "Anglo-Saxon" community there becomes less and less. Australia may be devoutly thankful that her soil is free from the African negro,—a worse scourge than the rabbit, and for the very same reason.

II. THE BIRTH AND EVOLUTION OF THE SOLAR SYSTEM.

TRANSLATED FROM PAGES 113 TO 132 OF "GEDANKEN" (1857, Philadelphia, published by Thomas).

By O. REICHENBACH.

(Continued from page 70.)

IN the analysis of bodily proportions which result from the first becoming and motion I have pointed out how excentricity of the equatorial plane is derived, and how it becomes a condition for unequal velocity of the sides converted to and averted from the attracting body, and for a process of condensation and dissolution. The planetary mass, unrolling with tremendous power, here projects matter to 77·3 r distance from the receding sun, and sends it to the opposite side by centrifugal force, where it is not repulsed, but re-attracted by the sun. Matter on the side averted from the sun does not extend to the distance of $680^2\ r$, but, under the recalling influence of a mass 680 times greater, only to—

$$\frac{680^2}{\sqrt{680}}r = 17{,}680\ r.$$

We have now limits of the planetary mass 77·3 r and 17,680 r solar distance; we have to find the point of gravitation, the real mean distance to which the mass rebounded. At the beginning of motion the measure was R. The required distance is the mean proportional of the forces opposed in mass and motion :—

$$\frac{1}{\sqrt[3]{680}} = \frac{1}{8{\cdot}8} \text{ and } \sqrt{680} = 26 \qquad \frac{1}{8{\cdot}8} :: 26 = 1{\cdot}72\ \text{R}$$

$$1{\cdot}72\ \text{R} = 1169{\cdot}6\ r \text{ distance,}$$

or by limits—

$$77{\cdot}3\,r :: 17{,}680\,r = 1169{\cdot}6\,r.$$

It lies somewhat beyond the mean distance of Jupiter. As the central part we must consider this quantity repulsed to $1169\,r$ distance, but a simple distance gives a point only. According to the rotary motion, which the central part received at first, it moved for its new site $\sqrt{1{\cdot}72}$ too rapidly; it went as central yet dissolved mass $1{\cdot}72$ farther, or this was the excentricity of the central evolution cycloid. The mass had, using a familiar expression, a perihelion and aphelion of rotation, between which the inner strata circulated. It went then to $1{\cdot}72^2$ of distance; consequently to—

$$1169\,r \times 1{\cdot}72 = 680 \times 2{\cdot}96 = 2006\,r.$$

We have the two points, poles, the one beyond Jupiter, the other this side Saturn.

But in this representation of unrolling through centrifugal force I did not account for the perturbations produced by the centrifugal force of the sun, yet they exist and continue through the whole development of motion, and the differences in effect on an extended body.

The opposite points of each body had to move with another rotary velocity than the mean ones, which brought them closer together; on the other hand, had the part converted to the sun to remain nearer to it, the averted part to remove farther from it, this is indicated by the proportions found.

The centrifugal force of the sun was 1-77·8, the planetary radius $77{\cdot}3\,r = 1\text{-}8{\cdot}8$ R. The rotary velocity produced by the sun so became, in the mean of the oppositions, diminished 1-8·8, and translation was increased by the same quantity. Rotary velocity became $77{\cdot}3 - 8{\cdot}8 = 68{\cdot}5$ times more rapid than that of the sun. It is therefore as if this body had $68{\cdot}5\,r$ as mean radius. The velocity of rotation became now, on the side converted to the sun,—

$$\frac{680 + 68{\cdot}5}{680} = 1{\cdot}107,$$

and on the side averted from it—

$$\frac{(680 + 68{\cdot}5) + (68{\cdot}5 + 2{\cdot}96)}{680} = 1{\cdot}22 \text{ times}$$

more than it had to be. The sun was not at the same distance from the converted and averted sides of the planetary

mass. Inversely as the square of distance, the force of approaching and staying behind must decrease.

As the central mass here moved away to 1·72 R, it had to remain behind with its part nearest to the sun—

$$\left(\frac{68{\cdot}5}{\sqrt{1{\cdot}72}}\right)r = 52{\cdot}4\,r;$$

we have $1169\,r - 52{\cdot}4\,r = 1116{\cdot}6\,r$ as the mean position of the central perihelion, as that of Jupiter; as the mass removed on the averted side to 2·96 R, it had to escape to—

$$\frac{68{\cdot}5\,r + 2{\cdot}96\,r}{\sqrt{2{\cdot}96}} = \frac{68{\cdot}5\,r + 2{\cdot}96\,r}{1{\cdot}72} = 41{\cdot}6\,r,$$

and $2006\,r + 41{\cdot}6\,r = 2047{\cdot}6\,r$, equal to the solar distance of Saturn. We have $52{\cdot}4\,r$ and $41{\cdot}6\,r$ as mean elongations or evections of the two central masses; quantities with which the quantities 1·107 and $1{\cdot}107^2 = 1{\cdot}22$ interfere as quantities of motion; the former as characteristic of the centre become perihelion, the second as that of the central aphelion, projection of the former.

When the body moves in remoteness 1·22 slower, it moves in proximity $\sqrt[4]{1{\cdot}22}$ times more rapidly: when it moves in its proximity to the sun, 1·107 faster, it goes in its remoteness $\sqrt[4]{1{\cdot}107}$ times slower. We so have the mean into the ideal distances:—

$$\text{Jupiter} \quad \ldots \quad \frac{1169\,r}{1116\,r} = 1{\cdot}049 \text{ (rounding } 1{\cdot}05).$$

$$\text{Saturn} \quad \ldots \quad \frac{2047{\cdot}6}{2006} = 1{\cdot}024\,r \text{ (rounding } 1{\cdot}025).$$

Their mutual distance is $1{\cdot}72 \times 1{\cdot}05 \times 1{\cdot}025 = 1{\cdot}84$.

$$1{\cdot}025 : 1{\cdot}05 = \sqrt[4]{1{\cdot}107} : \sqrt[4]{1{\cdot}22}.$$

These disturbance figures—

$$1{\cdot}025^3 = 1{\cdot}05$$
$$1{\cdot}05^3 = 1{\cdot}107$$
$$1{\cdot}107^3 = 1{\cdot}22$$

derived from the principal ones—

$$1{\cdot}72$$
$$1{\cdot}72^3 = 2{\cdot}96$$
$$2{\cdot}96^3 = 8{\cdot}8$$
$$8{\cdot}8^3 = 77{\cdot}3$$
$$8{\cdot}8^3 = 680$$

form the more complicated mechanism of the whole system.

We thus have the solar distances of the two central masses—

$$\frac{2047\,r}{1116\,r} = 1 : 1{\cdot}87.$$

Observation gives the densities of sun and planets. Slight differences of density between those observed and here deduced are irrelevant, for nothing is more uncertain than the exact mean diameter of planets, and for density the error increases to the cube.

Observation gives, if the density of the earth be taken as 1, that of the sun 0·252, of Jupiter 0·243. The density of solar and planetary mass was equal, but Jupiter remained 1·05 this side of the point of gravitation; so much less was it condensed, we have its density 1-1·05 of that of the Sun, or—

$$\frac{0{\cdot}252}{1{\cdot}05} = 0{\cdot}240$$

of that of the Earth. Observation gives the density of Saturn 0·140. It is—

$$\frac{0{\cdot}252}{0{\cdot}140} = 1{\cdot}8 = 1{\cdot}72 \times 1{\cdot}05 = \frac{1{\cdot}84}{1{\cdot}025}.$$

The density of Saturn is so much less than that of the Sun as its distance is greater than that of Jupiter when divided by that distance which it moved beyond its ideal position. This farther distance increases its density, as that of Jupiter is less by its remaining this side of the point of gravitation. The density of Saturn to that of Jupiter is therefore 1 to 1·72.

Observation gives the mass of the Jupiter system 1-1047·8 of the Sun; of the Saturn system, 1-3501·6. The former contains 3·345 more mass than the latter: 1 to 1·84 is the solar distance of Jupiter to that of Saturn; $1{\cdot}84^2 = 3{\cdot}45$, or inversely as the squares of distances are the masses of the two central concentrations, or Saturn is—

$$\frac{1}{1{\cdot}72^2 \times (105 \times 1025)^2}$$

of the mass of Jupiter.

The planetary rotation, 77·3 times more rapid than that of the sun, became diminished by the opposing centrifugality of the sun, gradually diminishing the oblateness of the

mass; transportation became accelerated, and the rapidity of rotation became 68·5 times that of the sun. If we thus might find the whole planetary mass in 1·72 R distance, it would rotate 68·5 times more rapidly than the sun. But as the mass remains in the perihelion of revolution 1·05 nearer, rotation becomes—

$$\frac{68{\cdot}5}{1{\cdot}05^2}=62{\cdot}5,$$

or so much more rapidly rotates Jupiter than the Sun. As the mass now circulates to the aphelion, and passes here $1\text{-}1{\cdot}025^2$ beyond its ideal position, rotation becomes $1\text{-}1{\cdot}025^2$ of that of the perihelion, or Saturn revolves only—

$$\frac{62{\cdot}5}{1{\cdot}025^2}$$

more rapidly than the Sun.

But the mass did not merely circulate between those two central parts in cycloidal form; it was projected to $77{\cdot}3\,r$ and $17{,}680\,r$ from the Sun. Could the conical extremes now keep up in transportation round the Sun with the central masses, and return to them; or had not mass to tear off on either side and to unite round poles,—that is, reversing points? Where now the translatory velocity in more and less was as 1·72 to the mean one, there the mass had to separate,—consequently in a solar distance of—

$$\frac{1169\,r}{1{\cdot}72^2}=397\,r,$$

and $11{,}69\,r\times 1{\cdot}72^2=3448\,r$, here beyond Mars, there this side of Uranus.

These tearing-off masses concentrated round projected points. We find, as their points of gravitation for the interior system—

$$77{\cdot}3\,r::397\,r=176\,r \text{ solar distance};$$

for the exterior one—

$$3448\,r::17{,}680=7808\,r.$$

The interior system, projected by Saturn, is repulsed; the exterior one, projected by Jupiter, is re-attracted by the Sun. An image of the process may be found in a comet which points with a small cone sunward, its substance flowing

from the side turned away from the sun and resting on its central portion,—and points with a larger cone away from the sun, its substance issuing from the central part of the side turned towards the sun. After separation had taken place the three groups adopted ellipsoidal forms, and presented an aspect similar to that which the three-linked comet must have shown about which Chinese chronicles tell us. The mass has four poles reduced to the equatorial plane; Jupiter and Saturn, the interior and the exterior system, each of the two latter systems presents again four poles. The mass, in shape three coupled zeros, circulates in double motion, and concentrates at the points of intersection and reversion. The asteroids are fragments and vapours condensed in the districts of separation.

It must be, of the whole mass, Jupiter—

$$\frac{1{\cdot}105 \times \sqrt{1{\cdot}025}}{1{\cdot}72}$$

Saturn—

$$\frac{\sqrt{1{\cdot}1025}}{2{\cdot}96 \times 1{\cdot}72 \times 1{\cdot}05}$$

The exterior system—

$$\frac{1}{29{\cdot}6 \times 1{\cdot}72 \times 1{\cdot}21 \times 1{\cdot}05}$$

The interior system—

$$\frac{1}{77{\cdot}3 \times 1{\cdot}72 \times 1{\cdot}05}.$$

The mass, not of Saturn, but of its whole complicated system, has retained mass at the expense of the exterior and the interior system, whereby the elongation of Saturn is somewhat smaller.

If we then divide the mass logically in 680 parts, the system of Jupiter contains 442 parts, Saturn 131, the exterior system 104·2, the interior 2·83.

Or it is not exactly, but pretty near, the mass of Jupiter to that of the exterior system, as the square of the mass of Saturn divided by the square of that of Jupiter to the mass of the interior system divided by that of Saturn.

Which are the relations of distances in the two separated systems? The points of gravitation are the hinges on which they swing. I begin, not quite logically, with the interior system, because it is the better known.

It is projected from Saturn, and re-attracted by the larger

Jupiter; the direct projection is Venus; the mass is recalled by Jupiter which produces the Earth. Mercury is the projection of the Earth; the latter nearer Jupiter yields less mass; Mars is the projection or circulating stratum,—the undulation of Venus, nearer Jupiter; the former obtains a larger share of mass from its central planet.

We have distance of Venus from the point of gravitation—

$$\frac{176\,r}{156\,r} = 1{\cdot}1 \times 1{\cdot}025 = 1{\cdot}22 \text{ aphelion.}$$

$$176\,r - 156\,r = 20r. \qquad 214\,r - 176\,r = 38\,r.$$

$$\frac{38}{20}\,r = 1{\cdot}9 = 1{\cdot}72 \times 1{\cdot}1.$$

We had as limits of the system $77{\cdot}3$ and $397\,r$. The latter figure was obtained by the central point of gravitation; the elongation of the central mass must produce a district of separation, inside which the separate mass oscillates. I take at once the inner and outer system.

We had separation at $397\,r$ distance. Saturn has an elongation of $41\,r$ (away from the Sun); its mass is $3{\cdot}345$ times less than that of Jupiter. From this farther distance follows a greater approximation of the rotary flux reacting against more rapid transportation; the point of separation is brought $41\,r \sqrt{3{\cdot}34}\,r = 72\,r$ nearer to the Sun, or $397\,r - 72\,r = 325\,r$, equal to the mean distance of Mars. The elongation of Jupiter is $53\,r$ (nearer the Sun); it results a reaction against the slower translation of the exterior system, which brings the point of separation to—

$$53\,r \times 3{\cdot}345^2 + 3448\,r = 4015\,r,$$

equal to the distance of Uranus.

Mars is the projection of Venus by the elongation of Saturn, whose direct projection is Venus; Venus was driven $1{\cdot}025$ beyond its simple excentric position. With Mars, the projection of Venus, the proportion is reversed; it is repulsed by Saturn. We have—

$$\frac{176\,r \times 1{\cdot}72 \times 1{\cdot}10\,r}{1{\cdot}025} = 326\,r$$

as distance of Mars.

Mercury is the projection of the Earth, which is $1{\cdot}22$ times

more distant than the point of gravitation; the solar distance of Mercury becomes—

$$\frac{176r}{1{\cdot}72 \times 1{\cdot}22} = 82{\cdot}8\,r.$$

A tertiary perturbation here becomes perceptible.

(To be continued.)

V. ON BRAIN-WORK AND HAND-WORK.

By R. M. N.

IT may seem presumptuous in me to take up a subject which has been ably dealt with some years back in the "Journal of Science," by occasion of Dr. Beard's treatise on the "Longevity of Brain-Workers." Still it appears to me that the last word on this topic has not yet been said. Certain points, both of distinction and of resemblance, seem to have been overlooked as well by reviewer as by author, and certain of the conclusions drawn are at least open to question.

I may perhaps be allowed to put the opening question, What is work? The common reply is, "Any pursuit by which a man earns or attempts to earn a livelihood, and to accumulate wealth." This definition is the more to be regretted because it cherishes, or rather begets, the vulgar error that all persons who do not aim at the accumulation of wealth are "idlers." In point of fact such men may be doing far greater services to the world than the most diligent and successful votary of a trade or a profession. Darwin, having a competency, was therewith content. To him, and to others of kindred minds, the opportunity of devoting his whole life to the search after scientific truth was a boon immeasurably higher than any conceivable amount of wealth. Shall we call him an idler? Nor is Science the only field which opens splendid prospects to men of independent means. Art, literature, philanthropy, have all their departments, unremunerative in a commercial point of view,

or at least not directly remunerative, and for all these cultivators are wanted. Therefore, reversing the advice given by routine moralists, I would say to wealthy young men of ability "Do not take up any trade, business, or profession, but do some of the world's unpaid work. Leave money-making to those who have no other option, and be searchers for truth and beauty." Everyone who follows this advice will contribute something to show the world that the race for wealth is not the only pursuit worthy of a rational being. I should define work as the conscious systematic application of mind or body to any definite purpose.

I said "of mind or body." Perhaps the expression may sound old-fashioned; so to avoid grating on the nerves of a monistic world I will say "of brain or muscle." But can we draw a sharp, well-defined boundary line between brain-work and muscle-work? Recent investigations into the functions of the brain show that it has the task of directing and co-ordinating muscular effort. The athlete, or say the musical performer, has not merely to strengthen his muscles and acquire flexibility of arm, hand, and finger; his exercises serve at the same time to develop and perfect those regions of the brain by which the muscles in question are actuated and co-ordinated.

Prof. Du Bois Reymond, in his admirable treatise on "Exercise" (reviewed some time ago in the "Journal of Science"), contends that "bodily exercises are not merely muscle-gymnastics, but also nerve-gymnastics," and that practice in the movements of the limbs is "essentially exercise of the central nerve-system." Hence muscle-work which is not at the same time brain-work is a chimera, which has no existence. But it will now be asked, Is there any brain-work without muscle-work? Undoubtedly; we may see phenomena, we may reason upon them, and come to a conclusion concerning their nature without any muscular action at all. But if we even wish to write down our results, or to tell them to a friend, some muscular action, small though it be, is needed. Or we wish to go further: not content with merely observing the phenomena which chance brings before our eyes, we go forth in search of facts. Here muscular-work is blended with brain-work. A step further: We wish to put definite questions to Nature, to perform physical, chemical, or physiological experiments. In all these cases the hand has to be the inseparable companion of the brain. The efficiency of the one will not compensate for inefficiency in the other. Now, the work of the experimentalist rarely requires great strength, but it

invariably stands in need of delicacy, nicety of touch and movement, bodily or, if you will, muscular, attributes to be reached only by training.

It is the same in the fine arts. The painter needs not merely an exquisite perception of form and colour, an instinctive—as it appears to outsiders—appreciation of their relations and harmonies; unless he possesses in addition to all this the requisite nicety of touch, he must fail to embody in visible form the conceptions present in his brain. Precisely the same is it with the musician. The orator and the actor must also, in addition to their mere mental gifts, have vocal organs thoroughly developed and disciplined. Thus we see that in the highest walks of science and art, brain-work and muscle-work exist, I might say, in a state of interpenetration.

Again, at a work-table in Y—— Street, sits a microscopist, carefully studying the peculiarities of a newly detected microbion, or dissecting the larva of the Phylloxera. What is he? Brain-worker, or muscle-worker? You pronounce him a brain-worker; his brain, in your opinion, doing the larger—the essential part of his task. So be it. I convey you to X—— Street, where at another work-table sits a microscope-maker. He is accurately adjusting an objective of high power. What is he? Like the user of the microscope just mentioned, he requires the utmost delicacy of touch, the highest manipulative skill. Like the microscopist, also, his brain performs the essential part of the task. But you will probably call him a hand-worker or muscle-worker, because he is a mechanic!

Surely, then, we must admit that there is no hard and fast boundary between the brain-worker and the muscle-worker. There is no muscle-work without brain-work; there is little brain-work of a high order without muscle-work.

There are, however, gradations. There are kinds of muscle-work, so simple, so monotonous or uniform in their character, that they are, with very little practice, performed automatically, with no conscious effort of the brain. Such, for instance, is the work of the agricultural labourer in digging, mowing, thrashing, &c., or of the hodman carrying bricks and mortar up a ladder. All such work, it is generally found, can be performed by means of machinery. Perhaps this may enable us to find a definition, or rather a limit for muscle-work.

I must now ask what classes of society can rank as brain-workers. Dr. Beard seems to include here, clergymen, lawyers, physicians, merchants, scientists, and men of letters.

He does not make any mention of artists, teachers of different branches of knowledge, manufacturers, &c. Now, if the merchant, the man who distributes, fetches, and carries, is to rank as a brain-worker, surely must the producer, who much more frequently originates out of his own mind something new to the world. We may also ask, Does the term merchant include the retail dealer, the clerk, and the commercial assistant? If so, we find the brain-working class reinforced by a number of persons who certainly have little need for muscular exertion, but little also for brain-work, and many of whose tasks and duties might be performed by machinery. Again, where are we to place the speculator, the gambler, and the forger? Muscle-workers they are only to a very small extent, though the forger requires a wonderful amount of manipulative skill. He must, however, be regarded as a doomed species, since the Nesbit patent safety-cheque carries in it the germs of his destruction.

It becomes very difficult to say with accuracy who are to be classed as brain-workers, and who as muscle-workers, and, still more, who are to be referred to Dr. Beard's third class, "those who follow occupations that call both muscle and brain into exercise." This class, as I have endeavoured to show, includes almost everyone who works at all. Until we are able to furnish a correct classification of mankind as brain-workers and muscle-workers, it will be very difficult to enunciate any true and valuable proposition concerning either group.

Twenty years ago, Dr. Beard laid down among others the following set of propositions:—That the brain-working classes—clergymen, lawyers, physicians, merchants, scientists, and men of letters—live very much longer than the muscle-working classes. That the greatest and hardest brain-workers of history have lived longer on the average than brain-workers of ordinary ability and industry. That clergymen are longer-lived than any other great class of brain-workers.

The first of these propositions admits of statistical proof or disproof. The life-lengths of the classes of men above mentioned can be ascertained, and their average duration compared with the mean length of life prevalent in their times and countries. But is the superior longevity of these classes due to the fact that they are brain-workers, or must it not be traced to a complication of causes? If brain-work is *per se* salutary and conducive to long life—which I do not deny—and if, as we may gather from Dr. Beard's second proposition here given, its beneficial influence is proportionate

to its intensity, we should find the men whose brain-work is devoted to origination stand highest in the list. As such I should undoubtedly rank discoverers in science, inventors in the industrial arts, poets, musical composers, and painters (not of portraits). But the third proposition entirely clashes with this conclusion. Dr. Beard tells us that of all brain-workers, clergymen are the most long-lived. Yet they can scarcely be called the hardest brain-workers, since what is demanded from them is not origination, creation, but expression. If a clergyman initiates new doctrines he is in danger of becoming a heretic. He is expressly forbidden to do what is expressly demanded from the man of science or the author. Indeed, till a comparatively recent date, the life of an English country clergyman has always been considered as one of the easiest of all careers, making no heavy demands either upon brain or muscle.

Indeed, Dr. Beard, when he undertakes a formal explanation of the great longevity of the clergy, makes some very important concessions. He remarks that "their calling admits of a wide variety of toil,"—"In their manifold duties their whole nature is exercised,"—"Public speaking, when not carried to the extreme of exhaustion, is the best form of gymnastics that is known." Dr. Beard here admits what I also maintain, that the most healthful work is that which duly and harmoniously calls into play all the various faculties of a man. Brain-work is in itself good and wholesome,—undoubtedly better than pursuits which exercise the muscles alone, leaving certain regions of the nervous centres inactive. But it is still inferior to work which exercises the entire system. Whatever calling effects this most thoroughly and equally, will be the ideal vocation. But it may be said that the duties of the physician call a wide circle of powers into play. Why, then, is he less long-lived than the clergyman? In his case there is wanting any physical exercise which may take the place of public speaking, and he is more exposed to death from contact with malignant disease.

As an instance of the especial benefit to be derived from an exercise of the whole system, I may glance at the lessons to be gathered from the experience of exploring expeditions in unhealthy countries. The first to succumb are porters, guides, muleteers, private soldiers and sailors, &c. Next come military and naval officers, whilst the doctor, the botanist, the geologist, &c., hold out to the last, their sole advantage being a more thorough exercise of the whole system, muscle and brain alike.

Dr. Beard gives another reason for the longevity of the

clergy—their comparative freedom from anxiety. This is the critical point to decide whether brain-work shall be healthful or harmful. Let a man work knowing that his livelihood is secure,—that it is indifferent whether he completes any given task this month or this time six months,—and no amount of study will harm him. But tell him that he must complete some task by a given date under penalty of dismissal, or that his prospects in life depend on his passing an examination better than a score of competitors, and the probability is that his studies will bring on softening of the brain, heart diseases, or perhaps Bright's disease.

Dr. Beard formally admits that "worry is the one great shortener of life under civilisation, and, of all forms of worry, financial is the most frequent and the most distressing." Hence the differences between his views and mine are very much smoothed over, and we must take in a "Pickwickian sense" his declaration elsewhere that "brain-work is the highest of all antidotes to worry."

He brings forward yet another reason for the longevity of clergymen—"their superior temperance and morality." That such superiority, if it exists, will have an influence in favour of health and long life, I readily admit. But it is very doubtful whether they are in this respect superior to other brain-workers. In the career of the scientist mutinous passions are simply crowded out. For him the struggles with temptation, of which the ethicists tell us, have simply no existence. How it may be among those brain-workers who move in a more emotional sphere, I cannot presume to say.

Dr. Beard's contention that the brain-worker is, as a class, happier than the muscle-worker is very questionable. He asks, "Where is the hod-carrier that finds joy in going up and down a ladder, and, from the foundation of the world until now, how many have been known to persevere in ditch-digging or sewer-laying, or in any mechanical or manual calling whatsoever, after the attainment of independence?" Such persons, I think, might be found. Many of these manual occupations would, as far as I can judge, seem happier than a life spent at the merchant's desk or at the exchange. If the man of business "continues to work in his special calling long after the necessity has ceased," it is because he has been trained to believe that accumulation of wealth is the whole duty of man. "Nearly all the money of the world," says Dr. Beard, "is in the hands of brain-workers." This may be true; yet, at the same time, many of the hardest and most capable brain-workers rank among

the very poorest. Young men are now warned by their friends to avoid the highest class of brain-work, and even to shun the learned professions, "because they do not pay." I meet with books containing the records of original research, yet for which the author has received less than the wages of a stone-breaker for the time employed. I meet with inventions which ruin the inventor and enrich his followers. Verily the manual labourer has scant cause to envy the brain-worker.

VI. ON TECHNICAL EDUCATION.

By Robert Galloway, M.R.I.A.

(Continued from page 97.)

ONE of the distinguishing features in the Educational System in Germany is the definite school system which is carried out in every part of that kingdom, under a fixed order of administration. This complete and perfect organisation of the different educational institutions in that country astonished the French Commissioners.* They say in their Report—"The most striking characteristic of the German institutions for national education is the general whole—the arrangement of all the establishments, which, from the primary school to the highest faculties in the university, offer the different classes of citizens a series of degrees of instruction which they may need or have the capacity to acquire."

Our school system, on the other hand, if it can be called one, is altogether unorganised; it is in a chaotic state, and yet it must be admitted that any national system of education—to be efficient—must be arranged on some well understood plan in which the object to be attained must be kept

* In 1862 the French Government appointed a Commission to visit Germany and other countries for the purpose of collecting the most precise information with regard to the systems of education adopted in the different countries they visited. The Report the Commission drew up on the subject the English Government afterwards had translated and published in the form of a Blue Book.

steadily in view from the very first. But of all our unorganised, aimless, objectless systems, the Science one under the Department of Science and Art appears to me to be the worst. A gentleman to teach under the Department must have obtained the Department's qualification to teach; but when he has obtained it, as he receives no payment from the Department except by results, he can start classes, and teach the pupils what sciences he pleases without regard to any plan or unity: he will teach those subjects only which will pay him the best in the place in which he establishes a class. He may teach, for instance, one year a class in elementary chemistry; next year he may teach, in the same place, if he thinks it will pay him better, elementary botany; in the third year, elementary geology; and so he may go on through the whole circle of the sciences, if he thinks he can get a sufficient number of students to attend in the different subjects. His sole aim will be to get as much money as he can on the result system, and he knows that to attain this he must in many places vary his subject from time to time: he further knows that as a rule he can obtain the most money by preparing his students for examination in the elementary stage of the subject only; in the majority of cases it will not pay nearly so well to go higher than the lowest stage. The taught will thus only acquire a smattering of the rudiments of one or more of the sciences, which will not prove a source of pleasure or profit to the majority of them, and such a system of science teaching can never be of any advantage to the nation industrially; and we can only expect to maintain for our manufactures a foremost position in the markets of the world, in the present day, by at least our middle class obtaining on an *ascending* scale of instruction in Science, as is done in Germany, a high class scientific education.

We shall bring under review, as we proceed, the number of students attending the elementary science classes under the Department of Science and Art, the number that pass, and the cost to the State of these classes: it will then be apparent that only a very small percentage of the students attending these classes go in for the higher examinations; but for the purpose of more forcibly illustrating what is about to be stated with regard to the *defects* of the system of teaching which has to be adopted by the teachers of these classes, I will here give the number of examination papers issued, and the number of successes, at the May examination in 1881. I give the number of papers instead of the number of *individual* students, because it is difficult, if not

impossible in some cases, as I shall show further on, to arrive at the number of individual students, owing to the manner in which the returns are given in the Department of Science and Arts Reports. The number of papers does not of course represent the number of individual students,—as a student may, and frequently does, go in for examination in several subjects, and he is furnished, of course, with a separate examination paper for each subject.

At the May examination, 1881, 72,300 papers were issued. The total successes amounted in round numbers to 67 per cent: of this total of successes 53 per cent passed, including both classes, first and second, in the elementary stage; 13 per cent passed, including both classes, in the advanced stage; and 0·7 per cent, including both classes, in the honours examination.

Teachers who prepare pupils for competitive examinations must teach the subjects of instruction in the way that will best prepare their pupils for the class of questions the examiners will be likely to give; but when the teacher's payment also depends, as it does under the Department of Science and Arts system, on the pupils passing, the teaching becomes completely and absolutely subordinated to the examinations. The teacher is entirely precluded from displaying any individuality in his teaching; he cannot teach his pupils according to their individual wants and capacities; he must teach on *the one groove* that will best prepare them for the examiner's papers. This evil system—for it is an evil one—is still further increased by the examinations as well as the administration being completely centralised. This system of examinations and competitions on the great scale is illustrated in China, "where it *has produced a general and incurable senility*." But we need not go so far as China to learn the ill effects of the system: we need only contrast two neighbouring nations, France and Germany, to learn the different influence on a nation,—whether the teaching is subordinated to examinations, as it is in France, or the examinations are subordinated to the teaching, as it is in Germany. The effects of these two different educational systems was strikingly shown in the Franco-German war: the officers and the men in the one army had been educated under one of the systems, and the officers and men in the opposing army under the other. "The unanimity," states the Right Hon. Lyon Playfair, in his pamphlet on Teaching Universities and Examining Boards, "is surprising with which eminent French men ascribe the intellectual paralysis of the nation to the *centralisation of administration and examination*." And

a like system must produce the like ingenious results to a nation to whatever grade of education it is applied. The late eminent French chemist Ste.-Claire Deville said—"The success of Germany is due to the liberal organisation of the German Universities. It is Science that has vanquished us." Renan, whose opinion I have given with regard to the effects of examinations and competitions in China, that they had produced a general and incurable senility, said—"In France we have already gone far in the same direction, and that is not one of the least causes of our abasement." The French provincial universities were destroyed by the great Revolution. Napoleon I. reconstituted the University of Paris in 1808, by making it the single university for France. "He did this," to employ Dr. Playfair's expressive words, "with the power of a military despot, and *with the professional instincts of a drill-sergeant.* The University now became the Department of State Instruction, and included every kind of education—primary, secondary, and collegiate; while Germany was multiplying its universities and establishing among them a most salutary emulation."

It is admitted by all sound educationists that it is far more important in the training of the mind to adopt the best methods of teaching than what subjects are taught,—in other words, how we teach is far more important than what we teach; but under such a system as that of payment by results the teacher cannot be an educationist; he can only be a crammer, and this is confirmed by the multitude of books on the different sciences which have been published since this system was adopted by the State: the books to which I refer, or at all events the vast majority of them, are purely and simply cram books; but the teacher finds that these are not always sufficiently attenuated to enable him to prepare with any success his pupils for the examination: he therefore either writes out answers to the examination papers that have been given for several years past on the subject he is teaching, and makes his pupils commit these answers to memory, and practises them by asking a certain number of the questions each time they meet and making them repeat from memory the answers,—or he selects the book on the subject which he considers to be the examiner's *pet one*, and he guts it, and condenses the necessary information for the examination into a sheet of letter-paper, along with the illustrations of the apparatus required for the experiments; he has this printed, and he supplies or makes each of his pupils buy a copy, and they have to commit the contents to memory.

Our representatives in Parliament vote each year a considerable sum of public money for the propagation of this unmitigated cram, under the misnomer "for teaching Science." Prof. Huxley has stated that "we study in these days *not to know, but to pass*, the consequence being that *we pass and don't know*"; but of all the systems that contribute to the extension and propagation of counterfeit knowledge, that of the Department of Science and Arts certainly excels every other. For by this system the majority of the students are not taught to observe and experiment themselves, and to state and reason on the results they have obtained, and yet observation and experiment are the sources of our knowledge of the Inductive Sciences; they are the most important and indispensable qualifications a student of these Sciences ought to possess. Instead of obtaining, as all students of Science ought, a "knowledge of things," which can only be obtained by observing and experimenting, the Department's students, owing to the system, only acquire the spurious article, "the names of things."

I believe we commence on a wrong and erroneous system for teaching some of the Sciences, especially Chemistry, and the Germans are no exception to the rule; we commence by teaching the facts of the Science by means of lectures. Even if the pupils could remember all the facts they are told in lectures it would be mere information, not knowledge, still less Science; if a student committed all the facts contained in Gmelin's great work on Chemistry to memory, it would not make him a chemist, for it would only amount to information. Hunter, in his "Principles of Surgery," has very succinctly stated the essence of all true teaching: he says "that his object was to fit his pupils to act as occasion may require from comparing and reasoning on known principles. Too much attention," he goes on to say, "cannot be paid to facts; yet too many facts crowd the mind without any advantage, any further than they lead to principles." "These words," states Prof. Humphry, "give the very marrow of sound teaching, and should be graven wide and deep on the walls of every school, and in the heart of every teacher. They have, alas! been too little heeded."

A person totally ignorant of Chemistry may be trained to perform mechanically certain chemical operations, as a man can be taught mechanically to work a steam-engine: the porter in a chemical laboratory, for instance, may be taught to prepare or purify certain compounds; boys, without the least acquaintance with the science, are frequently taught in chemical factories to analyse quantitatively the substances

manufactured in the particular factory to which they are attached, but they may—and, as far as such training goes, will—remain ignorant of a knowledge of the principles involved in the preparation or analysis of the substances on which they operate. But even this kind of information is superior in point of utility to mere verbal information, whether derived from a teacher or a book; for in the one case the party is able to accomplish something, whereas in the other case all that is possessed is merely the *names of things*, and, if this forms the *alpha* and the *omega* of the teaching of an experimental science, such information can never prove of any practical benefit to the taught, or to the State which has paid for such instruction. The late Prof. Augustus De Morgan made some appropriate remarks on this spurious knowledge in a letter he addressed, in 1853, to Prof. Michael Foster, in which he stated the objections he had to the system pursued in the London University. "For example," he states in the letter, "a candidate for the B.A. degree is required, in addition to matters which enter the ancient disciplines, to be examined in *animal physiology*. And he may pass this examination without knowing more, from his own observation, of what is under the skin of any animal, than he learns from the words of a book or the lines of a drawing which no one can understand except he be familiar with the original object. I will venture to say that a large majority of those who have passed the examination in physiology know nothing about the interior of the body, from their own observation, except that blood follows a cut in the finger. I appeal to the examiners whether it be not as I say, and whether the answers given do not clearly show it. Thus, for the first time in the annals of liberal education, a University has proclaimed that mere words, as words, with no meaning attached, are a worthy discipline."

Authors of educational works on, as well as teachers of, Science, too frequently overlook or forget that "the knowledge a man can use," as Mr. Froude has remarked, "is the only real knowledge, the only knowledge which has life and growth in it, and converts itself into practical power. The rest hangs like dust about the brain, or dries like rain-drops off the stones."

I have stated that I believe—and I speak with some considerable experience—we commence the teaching of some at least of the Sciences, especially Chemistry, on a wrong and erroneous system: instead of teaching detached facts, as is generally done, I would teach—along with exercises on the language of the Science, and what are now termed the

arithmetical problems—as thoroughly as possible the conditions under which combinations and decompositions take place. This method I made known in one of my works, "The First Step in Chemistry." The arithmetical problems have been almost universally adopted in the teaching of the Science in these countries, and also in America: the teaching of the language as laid down in my work has also been followed to a certain extent; but the plan of teaching the experimental portion of the Science by elucidating, by means of suitable experimental facts, the conditions under which combination and decomposition take place, has not been followed to any extent in these countries: and yet it is not only a very important part of my system, but it is more in accordance with the principles of all sound teaching than the one which is substituted for it; for whilst the information the students obtain by the latter system is mere empirical knowledge, by my system *reason*, *language*, and *observation* are cultivated together, and therefore the mind is disciplined for thought and action. It is as successful and efficient as a discipline for the mind with boys as with young men, and I have found, in the rather large experience I have had in practical working in different kinds of chemical factories, that many processes fail or work badly although correct in principle, owing to those who have the management of them not knowing or discovering the proper conditions for working them successfully.

(To be continued.)

ANALYSES OF BOOKS.

Upilio Faimali; Memoiren eines Thier bändigers. Gesammelt von PAUL MANTEGAZZA.* Leipzig and Heidelberg: C. F. Winter.

POSSIBLY some of our readers may feel surprised that we should select the memoirs of a tamer of wild beasts for notice in the "Journal of Science." We trust that the important observations in zoology and animal psychology made by our subject will fully justify our choice. Upilio Faimali was one of tbe earlier of those performers who travel about with caravans of wild beasts, and who minister to public curiosity by entering the dens of lions, tigers, leopards, &c., engaging in mimic combat with these monsters, and compelling them to perform a variety of tricks. The taste for these exhibitions Prof. Mantegazza rightly pronounces a survival—the last remnant of the taste which led the most delicate ladies of Ancient Rome to gloat on the savage games of the circus. So far is this instinctive blood-thirstiness from being eradicated that nothing save the Law prevents combats of wild beasts and gladiators from being revived in our unco' good humanitarian and bestiarian England. On reflection it does indeed seem strange to see a community suppresing by their united action what a majority of them in their hearts approve of, and, conversely, compelling by law or custom what they individually dislike. Of such action the instances are not few.

Upilio Faimali was an Italian,—a son of the nation which supplies the world with professional athletes. We may ask if this aptitude for performances requiring strength and agility is not an inheritance of the physical training which for so many generations characterised the ancient Romans more than any other people of the past or the present?

Be this as it may, Faimali was from a very early age distinguished for muscular power, activity, courage, and presence of mind. In his eleventh year he obtained an engagement in Didier's circus, and five years afterwards he astonished his employer and delighted the public with the equestrian performances of an ape which he had trained in secret. From that time his rise was rapid, and he soon possessed a menagerie of his own, with which he visited the chief cities of the Continent, and was everywhere successful. His adventures and his hair-breadth escapes we must pass over, mentioning merely that his favourite

* Upilio Faimali; Memoirs of a Tamer of Wild Beasts. Collected by PAUL MANTEGAZZA.

dressing for wounds was a mixture of finely pounded sugar and brandy. But we turn with especial interest to his observations on the various animals which were for so many years his constant and close companions. The first point to be noted is one which bears upon the distinct nature of species. Many experiments at hybridisation have, we know, failed, the young half-breeds produced being brought into the world dead or surviving but for a short time. But so greatly is the reproductive power of many animals affected by changes of climate, of diet, and other conditions, that their young of unmixed blood, born in captivity, rarely survive. Faimali had about eighty lion-cubs born in his menageries, but none of them survived beyond the third or fourth year. Young leopards generally died before the end of their first year, or became paralytic. The young of many other species are weak, and suffer from rachitis. A singular fact is that the mother often kills the young brood, or at least refuses to suckle them, unless kept in darkness for several days after their birth. This circumstance is noted in the case of the hyæna, the wolf, the lioness, the panther, and the tigress.

In docility, intelligence, and disposition towards mankind the large Carnivora differ greatly. The leopard is probably the most docile and affectionate; the jaguar less easily trained, and probably a more dangerous playfellow than any other member of the cat family: it cannot easily be made to let go whatsoever it has once seized.

In one and the same species Faimali recognises individuality as distinctly as in man. The degree of docility depends, according to him, upon the varying power of attention. The education of beasts should not be undertaken too early; a lion learns best in his third or fourth year. If taken in hand too soon he becomes confused, and is spoiled. It is remarked that lions from the Cape are cleverer and more docile than those from the Sahara or Senegambia.

The hyæna is pronounced to be the most stupid of all the animals exhibited in menageries; "it shows no attachment to its keeper, no gratitude for kindness, learns nothing, and is influenced only by fear."

Faimali possessed a very large white bear, but never entered its cage, as it never would obey him. With the black bear of Europe he often went through his performances, sometimes not without danger. We do not learn that either he or any of his contemporaries or successors ever attempted to tame a "grizzly." We suspect this would prove a desperate undertaking.

Faimali's observations on apes and monkeys are in conformity with the views of the New School. He considers the chimpanzee the most intelligent animal which came under his observation. He notes that he never saw one of this species "perform the last stage of digestion" in public. This is an instance of decency superior to that shown by many of the human race, and contrasts

glaringly with the conduct of apes of the baser sort, from whose actions even Till Eulenspiegel might have learnt new lessons in impropriety. Faimali notices also the intense attachment of monkeys and baboons for their mates: the male and female often die of grief if separated.

Animals of the cat-family, if born in captivity, suffer much when cutting their teeth. Those caught wild are apt to perish of pulmonary consumption, a disease which is still more common among the Simiadæ, and which, curiously enough, generally terminates the career of the trainers and keepers of wild beasts.

In opposition to many high authorities, Faimali pronounces the lion stronger than the tiger, though the latter is more agile and uses its canines with greater skill. The two species rarely agree together.

The little work before us well deserves the study of the naturalist, the more because the large Carnivora are evidently and of necessity doomed to extirpation, and because a prolonged study of their habits is thus becoming from decade to decade more difficult.

The Remote Antiquity of Man not proven: Primeval Man not a Savage. By B. C. Y. London: Elliot Stock.

THE author of this work is evidently a laborious reader. There are few authorities bearing upon the subject which he has not taken into consideration. Even stray paragraphs in newspapers have not escaped his attention. Nor can it be denied that the subject of his inquiry is at once legitimate and of profound importance. But we can by no means feel satisfied with the spirit he displays. An investigation into the antiquity of mankind ought surely to be taken with judicial impartiality. B. C. Y. evidently has a strong bias in favour of traditional notions as against the results of modern research. Any rumour of evidence for the high antiquity of our race is to him a "scare." He argues throughout like a barrister who, in dealing with a mass of circumstantial evidence, seeks to put upon it any and every interpretation consistent with the interests of his client. He seems to be under the impression that if the various facts hitherto adduced in favour of man's existence upon earth for untold thousands of years can be held up us questionable or indecisive, we shall then have to go back to the conventional chronology of some 8000 to at most 10,000 years. This seems to us a most serious error. If all the conclusions of geologists, drawn it must be remembered from the actual inspection of the phenomena, and not at second-hand from mere reading, are insufficient, the utmost that can

follow is an admission that the antiquity of man is totally unknown. B. C. Y. has not a particle of evidence to show definitely and positively the non-existence of man, say 20,000 years ago. He relies on traditions. We must rule that on such a subject the traditions of ancient nations are no more receivable in evidence than would be the alleged testimony of an individual man who should profess to tell us, of his own knowledge, the history of his early childhood. There is an *à priori* objection to brachy-chronology, as the late Mr. Gosse called it; it is one of a bundle of notions on the earth, on man, and on his surroundings, held in the pre-scientific ages. Most of these notions proving to be false, in as far as they have been brought to the test of observation and experiment, we may fairly expect that the same will be the case with the rest.

We are curious to know what the author would say concerning the foot-prints recently discovered at the Carson State Prison? Would he accept them as conclusive, and strike his flag? Or would he seek to deny their antiquity, or their human origin?

We may believe that the earliest men were not savages when we can find a child born fully versed in the sciences and arts, and not requiring education.

The author's remarks on the formation of the different races of mankind by the action of climate, including a quotation from Buffon, are not very happy. Complexion is not the characteristic of races, nor is it dependent upon climate. The native race of America shows the same complexion in all latitudes. We are told of the black Jews in Cochin; but these Jews are in features, shape of skull, and general structure no step nearer the Negro type than are their fairer kinsmen in Northern Europe. Again, if the Negro has—as the author substantially admits—undergone no marked change in the last 3400 years, what length of time, we ask, would be necessary for his differentiation from the white race?

At the very close of the book the author formally declares war against Evolution, so far at least as Man is concerned. He declares that the transformation of any brute into man could not have occurred "without some of the intermediate nondescript forms being discovered." This is a hazardous assertion. We can infer little, if anything, from the silence of the great stone book.

There is a further point to which we must draw attention: the author declares himself not hostile to Science; but Science, according to him, must consist simply in noting and chronicling facts. We must not theorise. But a mere catalogue of facts, not to be explained or co-ordinated, is not Science. Indeed it is hard to say where pure observation ceases and where inference begins. Alike in Science and in common life, the two are blended in a manner which almost defies extrication.

B. C. Y., unfortunately, is one of those who still reject the

luminous principle laid down by Galilei, that in astronomy and physics, and in like manner in geology and biology, the Scriptures merely embody the current notions of the day when they were written, and can claim no scientific authority whatever.

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*Reinhold Buchholz Reisen in West Afrika, nach seinen hinterlassenen Tagbüchern und Briefen, nebst einem Lebensabriss des Verstorbenen.** Von CARL HEINERSDORFF. Leipzig: F. A. Brockhaus.

WE have here to call the attention of our readers to the career and the researches of a most able and promising naturalist, lost to Science at the early age of 39. In his earlier history we find much which powerfully excites our sympathies. He was, so to speak, a born student of nature, and especially a zealous entomologist—not, be it understood, like so many boys, a mere collector, but an intelligent observer. He was, too, like ourselves, in early life an enthusiastic admirer of Oken, whose works he eagerly devoured. Both in his home at Juditten, a district famed for the richness of its flora and insect-fauna, and afterwards at the house of his guardian, Herr Becker, in Königsberg, where he became a pupil of the local college (Gymnasium), he enjoyed full opportunity for the prosecution of his favourite pursuits. Unhappily, his guardian, a government official, was transferred to Berlin, and placed young Buchholz in the Jaochimsthaler Gymnasium of that city. This was the most unhappy part of his life. He was not understood either by his companions or by the heads of the institution. It was, apparently, one of those narrow, Procrustean establishments, less common in Germany than in England, where the individuality of the pupils was ignored, aud where one inflexible curriculum was imposed alike upon all. The occupations of the boys even in the hours of leisure were, as far as possible, brought under an Act of Uniformity, in a manner that reminds us of the compulsatory foot-ball and cricket in some of our English public schools. As an incipient naturalist, he was regarded as a black sheep, and some disorder having occurred in the establishment, he was advanced to the rank of scape-goat, and expelled without a particle of evidence. This injustice was, in reality, fortunate. He returned to Königsberg, where the head-master of the Collegium Fridericianum understood his disposition, and where he soon became the pride and the ornament of the college. Here he gained the friendship of Dr. Julius Schumann and Professor Zaddach, both naturalists

* Travels of Reinhold Buchholz in West Africa, from his Journals and Letters, with a Sketch of his Life.

of merit, whose intercourse greatly contributed to the development of his mind. At the age of twenty he began his medical studies at the "Friedrich Wilhelm Institut," at Berlin. Here he was also employed by the brothers Schlagintweit, to assist them in classifying the rich botanical treasures which they had brought home from Central Asia. He did not, however, remain longer than five terms at the Friedrich Wilhelm Institute, as each term bound him to a year's service as medical officer in the army. In his twenty-fourth year he graduated as Doctor of Medicine, his inaugural dissertation being "De Periostei Transplantationibus." In preparing this thesis, physiological experimentation was necessary, and some of our modern zoophilists will doubtless be disposed to read the commination of Ernulphus over his grave if they learn that during the summer vacation his mother's house was a perfect hospital of dogs and rabbits which had undergone operations. His next work was a contribution to helminthology —the anatomy of the genus Enchytræus, with a notice of the species occurring near Königsberg. In this memoir, according to Professor Langlois, he proved himself an expert dissector, an acute observer. and an excellent microscopist. But we must hasten on, briefly noticing the remission of his five years military service—a special act of royal favour,—his histological researches on the nervous system of the Mollusca, his appointment at the Zoological Museum at Greifswald, his obtaining the second degree of Doctor of Philosophy, his journey to Naples, where he spent three months chiefly in the study of the Crustacea, and discovered seven new species. In 1869 he took part in the second German polar expedition, and underwent severe hardships by the wreck of the Hansa, when his collections, drawings, note-books, and instruments were lost. Here he appears to have suffered from serious nervous disease. On his recovery he undertook the arrangement of the collections made by Dr. Pansch, the naturalist on board the more fortunate companion-ship, the Germania. In 1872 he received the appointment of extraordinary Professor of Zoology at the University of Greifswalde. In June of the same year he undertook, in company with Dr. Lühder and Dr. Reichenow, his last and most brilliant journey to the Gold Coast, the Mountains of Camaroons, Fernando Po, the Gaboon, and the Ogowi. The expedition was most successful, and in 1875, Buchholz returned to Greifswalde richly laden with treasures. In January, 1876, he was appointed to the ordinary Chair of Zoology at the University, and the Directorship of the Museum. But his end was near. His constitution, never apparently very strong, had suffered much from the climate of equatorial Africa. A violent cold developed into inflammation of the lungs, and on April 17th his short, but most honourable, career came to an end.

We turn, now, to his African expedition. His observations on the marine fauna began even in the North Sea, and were continued most of the way. The vessel sailed too swiftly to admit

of dredging or netting, but by pumping up sea-water and straining it through fine cloth, he succeeded in obtaining a frequent supply of small, but often highly interesting, Crustacea.

He notes that the flying-fish during their flight often changed their direction and effected striking movements. He considers that they accomplish these evolutions by touching the water in their flight and steering with the tail.

On landing at Akkra, Dr. Buchholz, like most naturalists who for the first time set foot in a tropical country, was delighted with the large and splendid butterflies, the large brilliant wasps belonging to the genera *Pepsis*, *Sphex*, *Pelopous*, &c. He found, however, great difficulties in the preservation of his specimens. A small fly pertinaciously tried to lay its eggs in the insects. Swarms of ants put in an appearance, whilst if the boxes were closed the contents became mouldy. This shows the necessity of having at hand proper poisons to spoil the appetite of marauders. The Termites were an especial object of our traveller's investigation. Many large hills which he broke open were deserted by their original inhabitants, but peopled with various wasps, bees, ants, spiders, &c. An occupied hill was found to contain workers, and two kinds of soldiers, large and small, but neither queen nor brood. A violent attack of fever put a temporary stop to the researches of Dr. Buchholz. He was told that this early attack was a good sign, as those who were not seized with the fever until later were in much greater danger. He resolved, however, to penetrate further inland to the village Aburi, situate on a hill about 1200 feet above the sea-level. On the way he found a "fabulous" wealth of insects, especially magnificent butterflies of numerous and often novel species. Scarcely less striking was the flora which displayed wonderful ferns, climbers, magnificent palms, and other huge trees, many of them covered with huge splendid flowers. At Aburi the climate was healthier, and the air drier, so that Dr. Buchholz had less trouble with his specimens. He points out as an error the common notion that the indigenous negroes are proof against the fever on the low coast-lands. They, too, are often attacked, though, as might be expected, less severely than strangers. The coffee plantations are much damaged by a "boring worm," probably a larva. Parrots, monkeys, &c., were scarce, but insects were found day by day in astonishing variety. Hence, whilst Buchholz remained for some weeks at Aburi, his companions, whose main object was ornithology, returned to the low grounds. He paid much attention to the driver-ants, two species of which at times do no little damage. They have been known to kill and partly eat a sheep which had been tied fast, to scare serpents out of their holes, and to turn out the entire congregation from the Mission Church. Like the termites, the drivers have large-headed soldiers as well as workers. A yellow species of ant, belonging to the *Myrmicidæ*, makes its nest of green living

leaves. Buchholz watched them rolling up the leaves and cementing them together with a white silky matter proceeding from the mouth. The termites were of a smaller species than those at Akkra, and their nests did not exceed 2 feet in height. They have two kinds of workers, and only one kind of soldiers with unsymmetrical mandibles. The queen's cell was not larger than the other cells. In no instance could Buchholz find a king, or two queens in the same nest. From Aburi he was able to send home no fewer than 700 butterflies. It appears that the natives have already adopted the Eucalyptus as a remedy for fever. After his arrival at Camaroons, Dr. Buchholz found it necessary to separate himself from his companions, Lühder and Reichenow.

Among the Duallas, Buchholz remarks the frequency of albinism, which sometimes occurs in patches, producing a piebald appearance. He considers it a mistake to pronounce the negroes of this coast as defective in the calf of the leg. He finds them, also, by no means very prolific. It is rare for a woman to have more than two children.

The price of a slave at the time of his visit was about £1. He considers that slavery and the slave-trade have not been called into existence by the necessities of European colonies in hot climates, but are original phenomena, connected with the very nature and character of the black race.

Whilst at Victoria, which he paints in no very pleasant colours, Buchholz made a careful study of *Chamæleo superciliaris*, *Owenii*, *cristatus*, and *montium*, the last mentioned being new to science. The district swarmed with splendid butterflies, beetles of the curious family Cassididæ, robber-flies (*Asilus*), dragonflies, &c. But, whilst collecting and studying these creatures, he was himself studied by the most offensive mosquitoes (*Simulium*), sand-flies small as dust, but occasioning intense torture, and Glossinæ, a form bordering on the redoubtable Tsetse of South Africa. Unfortunately the author had not the opportunity of anointing himself with kerosine oil, which several American naturalists have found very effectual in keeping blood-sucking flies at bay. Spiders were remarkably scarce. Almost the only ones seen were small hunting-spiders. Several new Batrachians were observed, especially a species of the genus *Plantymantis*, hitherto found only in Australia and the Malayan islands. *Chiromantis Guineensis*, a large brown tree-frog, deposits its spawn in frothy white masses upon the leaves of trees, in which the larvæ make their appearance.

Whilst at Victoria he experienced many attacks of fever, and was rarely well. He found the decoction of Eucalyptus of little value. Mention is made of a poisonous serpent (*Atractaspis*); it is about seven feet in length, and of a black colour, and occasions much damage. In the beginning of the year 1873, Dr. Lühder died, and Dr. Reichenow, shattered in health, returned to Europe, so that Buchholz remained alone.

Among the customs of the Bakhwiri tribe particular emphasis is laid on the witch-trials. If a person of note has died a natural death, or has been killed by a leopard, a death-snake, or a crocodile, someone is accused of having bewitched him, and is tried by ordeal with a decoction of the poisonous sasha-wood.

Among the vegetation of Bonjonjo he remarks the beautiful ferns and orchids, and a large Calla which flourished in every swamp.

Dr. Buchholz was induced by Lieutenant Grandee, of the English Congo Expedition, to try Dr. Günther's method of preserving birds without skinning. The entrails are removed, and the body filled with dilute carbolic acid, 1 part in 20. The process did not prove successful, as the feathers generally became loose before the body was dry.

On the Gaboon it was found that the sand-flea of South America (*Nigua*) had been successfully acclimatised, and was becoming a great nuisance. It appears that the natives make use of a curious poison. The teeth of venomous serpents are boiled up, and the juice is mixed with a powder, as Buchholz believes, some form of strychnin. Fine wooden needles are dipped in this poison, and a slight scratch or puncture with these is fatal. This statement confirms the view that the venom of serpents is a chemical individual, and not a ferment. Dr. Buchholz describes a nest of termites, which contained not fewer than three distinct species of termites, and four kinds of ants, which, when the nest was broken open, attacked the termites. The mutual relations of these different species constitute an interesting but difficult problem. In the same nest were many wood-lice, coleopterous larvæ, scolopendras, &c., and to complete the whole a swarm of wandering ants appeared, burst into the nest, and re-appeared, carrying off numerous termites as booty.

Shortly before his departure from Africa, Buchholz had the rare pleasure of making the acquaintance of a living young gorilla. It was of a more phlegmatic melancholy character than other specimens which have been taken alive. A remarkable point was that the animal, in striking at or grasping at anything, always turned the palm of the hand upwards. Whether it was disposed to strike outwards, centrifugally, or only inwards, as do the Felidæ, Dr. Buchholz does not say. It showed little inclination to climb, and was in fact clumsy. When sleeping it assumed perfectly human attitudes.

But our space is exhausted. We have not been able to notice even in the most superficial manner, one-tenth part of the important observations and discoveries made by Dr. Buchholz. No naturalist, we feel sure, can read this book without profound regret that the career of so able and accomplished an investigator should have been brought to an untimely end, and without, in spirit, depositing a spray of laurel upon his tomb.

Palæozoic Rocks of Galway, and elsewhere in Ireland, said to be Laurentian. By G. H. KINAHAN, M.R.I.A., &c. (From the Scientific Proceedings of the Royal Dublin Society.)

FOR some years a difference of opinion has existed as to the age of certain palæozoic rocks in Donegal, Tyrone, Mayo, Wexford, and in other parts of Ireland. Jukes and King refer some of the rocks in question—among others those of the celebrated "Twelve Pins of Connemara—to the Laurentian Age. T. Sterry Hunt, twenty years ago, admitted that some of the Donegal rocks seem lithologically identical with the Laurentians of America, but that other rocks from the self-same area "cannot be distinguished from altered palæozoic strata in America more recent than the Laurentians."

The author now took up this question, and enumerated various palæozoic rocks in Ireland approaching the Laurentians in their lithological characters, but being otherwise similar to the more recent Huronian strata of America. In the memoir before us he shows the deficiency of proof as to the alleged Laurentian Age of the Irish rocks in question. If the strata in question are Laurentian, many others, admitted on good evidence to be of Cambrian, must be relegated to the same group. Not without reason he accuses the Laurentianists of laying too great weight upon lithological characters, and too little upon stratigraphical evidence.

As far as can be learnt from the memoir before us, and of the accompanying plates of sections of the Twelve Pins and of the Corcogemore Hills, we must consider Mr. Kinahan perfectly justified in the position which he assumes, namely, without asserting that there are no Laurentian rocks in Donegal, he maintains that conclusive proofs of their existence are still wanting.

Longman's Magazine, No. IV., February, 1883.

THIS number contains two articles on scientific subjects. Mr. Grant Allen discourses on a "mountain tulip" (*Lloydia serotina*), and draws lessons from its peculiar distribution. These lessons, however, would make no impression upon a votary of the Old Natural History, who should maintain that the flower had been specially created in all the situations for which it is adapted. We heartily agree with him in his regret at the extirpation—approaching or already effected—of not a few of our rarer plants. This catastrophe is due perhaps more to dealers

in plants than to botanists properly so-called, though among them not a few may be accused of greediness.

Mr. R. Proctor communicates a paper on "The Photographic Eyes of Science," or, in other words, on the use of photography in astronomical research.

"A Farewell Appearance" is "a dog-story for children." If its author were so disposed he might write a true and sadder dog-story,—of a little girl at Crouch End who has become hopelessly mad from fright caused by a dog jumping at her in the street, and who, in one of her paroxysms, lately tried to kill a younger sister with a knife. The story, however, would not be for children, but would be an appeal to the conscience of dog-worshippers.

Reasons demanding an Answer. An Inquiry into the Basis of what is commonly called Christianity. London: W. P. Collins.

An examination of this little work does not come within the province of the "Journal of Science."

CORRESPONDENCE.

*** The Editor does not hold himself responsible for statements of facts or opinions expressed in Correspondence, or in Articles bearing the signature of their respective authors.

SPEECH IN ANIMALS.

To the Editor of the Journal of Science.

SIR,—I have read the article on this subject in the January number of the "Journal of Science" with considerable interest, especially as the idea of civilising monkeys by the hereditary accumulation of training influences was suggested to myself some years ago by the following rather instructive incident:—

Visiting the monkey-house of the Zoological Gardens I was much struck with the remarkable frontal development and intelligence of expression and conduct of a small monkey,—so much so that I sought out the keeper in order to obtain information respecting the species and habitat of the specimen. He told me that it *was born in the monkey-house*, and if I remember rightly he spoke of it as the only instance of such birth; but of this I am uncertain. It died shortly afterwards, probably of consumption, which kills so many of the imported animals.

This case shows the possibility of breeding monkeys in confinement, and justifies me in making the following suggestion:—Let a careful selection be made of well-matched healthy pairs of *gentle* monkeys, and, instead of shutting them in cages, give them the range of a sub-tropical conservatory like the Palm House at Kew Gardens, but feeding them from the hand, and otherwise promoting that personal attachment to man which has so much influence in developing the moral and intellectual powers of the lower animals,—a development which in man we call "civilisation," in animals "taming," but which is virtually the same in both cases.

As an example of the possible docility and affection of such animals I may describe a case which I now have continual opportunities of observing. My friend and neighbour Dr. Branthwaite, of Harlesden, had a small monkey from Penang given to him about eighteen months ago. It lives in his

consulting-room during the greater part of the day, and sleeps in a hutch in the adjoining surgery.

This animal has all the affection and gentleness of a lap-dog. He sits on his master's lap or shoulder, and cries pitifully if driven off and when the doctor goes out. He is similarly attached, though less strongly, to all the other members of the family, excepting the baby, which, when nursed and fondled, becomes an object of jealousy. One favourite mode of displaying affection is to rest his face in the hand, and look up to the eyes of the object of his love, with a ridiculously sentimental spoonyish expression.

I need not describe his tricks and other indications of intelligence, but name the above to show that there is no difficulty in obtaining monkeys that may safely be allowed the range of suitable places of public resort; that a monkey-house might be specially built and furnished with suitable growing trees in such a place as the Zoological Gardens, the Crystal Palace, or the projected Winter Garden at Brighton, and kept warm by stove-heat during winter; and that such a house might be stocked with a moderate number of pairs of gentle monkeys, where, having the opportunities of exercise suited to their natural organisation and habits, they would have a fair chance of propagation such as the present caging must tend to suppress, especially in animals of their extreme sprightliness and activity.

It would probably *pay* from a "show bisniss" point of view, as the unfettered gambols and "flying trapeze" exploits of these nimble and grotesque creatures would be very amusing, and the interest attached to their possible progeny would render the certified babies very valuable.—I am, &c.,

W. Mattieu Williams.

JOHN BUNYAN AND THE GIPSIES.

To the Editor of the Journal of Science.

Sir,—With reference to what appeared in your issue for January I beg to say that I sent the two pamphlets on John Bunyan and the Gipsies to the "Journal of Science" for the reason that I believed it specially came within its sphere as that of a scientific journal. The Gipsy question, in its essential meaning, is, I think, one of pure Science, and, as I wrote in 1865, "furnishes, among other things, a system of Science not too abstract in its nature, and having for its subject-matter the strongest of human feelings and sympathies." My grounds, among others, for saying so are the following:—

1st. What is it that constitutes a Gipsy? and what must he do to "cease to be a Gipsy," and become more a native of the country than he is already?

2nd. Do habits, character, creed, or any other thing change this race or family into another, so that there is nothing connected with the blood to distinguish it, in fact or feeling, from the other inhabitants of England?

3rd. Does this race, in consequence of the prejudice against it, maintain an incognito against "Jews and Gentiles," and frequently against part of "the blood" itself?

4th. Does this blood, never having been acknowledged, and therefore existing in an outcast condition, transmit to its descendants a "sense of tribe and a soul of nationality," so that they maintain a feeling of being members of a race or tribe that is universal, with words and signs or a sympathy that is peculiar to all such?

5th. What effect has the mixture of this blood on that of the ordinary native, when the marriage is with an incognito Gipsy, or one known to the world as such?

6th. Does not the sentiment of being "a Gipsy" consist in the connecting Gipsy link as to blood, and the children being brought up from infancy to know that they are "Gipsies" or "members of the tribe," and having the feeling strengthened and confirmed by associations with relations and friends who hold themselves to be the same, so that we can find the Gipsy sentiment in various positions in life, and sometimes closely connected with families of the ordinary natives of the country?

These are reasons which I think bring this question before some of the scientific journals of England, which should be the first to take it up on the grounds of fact and reason, apart from feelings of any kind. By them the Gipsy question should be thoroughly investigated and settled, and the Gipsy element in society—from the tent upwards—respected according to the merits of each member of it; so that no prejudice should exist against it as part of the complex population of the British Isles, embracing many thousands in various positions in life. In this way I think that, merely as a question of the "Science of race," it constitutes a legitimate subject of discussion for Journals of Science of many kinds.—I am, &c.,

JAMES SIMSON.

New York, January 27th, 1883.

[Such questions as Mr. Simson raises in the above letter are undoubtedly legitimate subjects for scientific consideration, and there cannot be any objection to their discussion in our pages. But the questions whether John Nokes or Thomas Styles belonged to some particular tribe seem to us of a totally different order.—ED. J. S.]

ZOOPHILISM EXTRAORDINARY.

To the Editor of the Journal of Science.

SIR,—In these days, when to poison a mouse in the interests of Science is a serious offence, it is interesting to find that cock-fighting is experiencing a revival. In Birmingham—which according to a modern statesman is "civilising England," and which recently forbad one of the professors at the Mason College to apply for a license to perform physiological experiments—it is, according to a local paper, "a common thing, in certain beer-houses in that town, to promote the exhibition of dog-fights of a most brutalising description. Only the other night upwards of forty persons assembled in the garret of a public-house, where a pit was constructed of circular boards, fixed with hooks, so as to be capable of dexterous removal in case of a police raid. In this arena two fierce bulldogs, with a stake of £50 depending upon the result, fought with mad fury for forty-seven minutes to an accompaniment of applause and wild yells of delight. A more sickening spectacle it would be difficult to conceive. One of the animals was torn literally to pieces and fell dead upon the floor, and the other was carried away in a terribly mangled condition." Have the "Bestiarians" no word in protest, or is the liberty to tear each other to pieces one of the "equal rights" which the bulldog is to share with the human "rough"?—I am, &c.,

GRADUATE.

SPACE OF *n* DIMENSIONS, AND THE "UNSEEN UNIVERSE."

To the Editor of the Journal of Science.

SIR,—The conception of space of more than three dimensions, the possible existence of which seems looming upon the mind of some of our most eminent mathematicians and physicists, such as Zöllner, Clifford, and, among the living, Dr. Spottiswoode, may perhaps throw a light upon the existence of a whole series of Unseen Universes, co-existent and mutually inter-penetrating. We live and act in tri-dimensional space. At death we pass into 4-dimensional space, still retaining our power of seeing into, and under certain conditions of interfering in, tri-dimensional space, but incapable of seeing into or conceiving the existence of 5-dimensional space. As our nature becomes more highly developed we pass successively into 5-, 6-, &c., dimensional space,

our perceptions and our powers constantly increasing as we approach, without ever reaching a universe of space of ∞ dimensions. This universe is inhabited by One Being only, who is, in virtue of that sole fact, omnipresent, omniscient, and omnipotent. I am not prepared to develop, much less to demonstrate, this hypothesis, but beg merely to put it forward for the consideration of your readers—I am, &c.,

V.

CARLYLE AND THE DARWINS.

To the Editor of the Journal of Science.

SIR,—A certain Mr. Henry G. Atkinson writes—"Carlyle says that the three Darwins—grandfather, father, and Charles—were atheists; and as he knew them all, his statement may be taken as thoroughly reliable." You will rate Carlyle's testimony in this matter at its exact value if you reflect that he was *six years old* when Erasmus Darwin, the grandfather, died, and that we have no proof that the two ever came within a hundred miles of each other.—I am, &c.,

C. F.

ARTIFICIAL LIGHT IN THE PAST.

To the Editor of the Journal of Science.

SIR,—In proof of the small use of artificial light in former times, referred to in your last number, I beg to inform you that country people in the North of England, even down to the middle of the last century, had no candlesticks but home-made ones, moulded of clay. Such were duly made every autumn, and as duly thrown away in the beginning of February. A very old lady whom I met with when a child told me that, in her young days, boys used to go about on the 2nd of February singing—

"It's Candlemas Day,
Throw your candlesticks away."

MOTTRAM ST. ANDREWS.

NOTES.

A PUBLIC Meeting was held on the night of January 31st in the Young Men's Christian Association Hall, Manchester, under the auspices of the International Association for the Suppression of Vivisection, to protest against physiological experimentation. A letter was read from Mr. Jacob Bright, M.P., stating that he had never been persuaded that the results of vivisection at all compensated for the suffering inflicted upon animals from its practice. There was a large attendance, and it was made manifest from the beginning that the promoters of the meeting were in a hopeless minority. Prof. Gamgee, of Owens College, led the opposition so far as speaking was concerned, meeting with a most enthusiastic reception. All the three resolutions moved by the Anti-Vivisectors were rejected, amid great cheering, with majorities of at least twenty to one. The proceedings closed with a round of cheers for Prof. Gamgee. We have never "been persuaded" that Mr. Jacob Bright is an authority upon methods of scientific research. But there prevails a superstition that an M.P. must understand all questions and all subjects.

Mr. C. Lloyd Morgan has published in "Nature" an ill-advised account of certain experiments upon scorpions.

Dr. W. A. Hammond, of New York, contends that the "seat of instinct" is the medulla oblongata. He bases his argument upon the power of acephalic monsters to suck, provided the medulla is present. (But what proves "instinct" to be a unitary faculty, having a seat?)

Mr. J. A. Newlands, in a communication to the "Chemical News," claims for himself the prior discovery and announcement of the "periodic law," the merit of which has been ascribed to MM. Mendelejeff and Lothar Meyer.

A medal has been presented to M. Dumas in commemoration of the fiftieth anniversary of his election as a member of the Academy of Sciences.

M. A. Gaudry ("Comptes Rendus") considers that the examination of primary fossils leads us to admit passages from species to species, from genera to genera, and from families to families.

Silpha reticulata, *S. atrata*, and *Phosphuga opaca*, all naturally carrion devourers, have taken to consume the sugar-beet, both in their mature condition and when larvæ.

According to Mr. H. Pollard, the Secretary of the Leeds Naturalist Club, two house martins were seen near Barnsley on October 23rd, and a young one at the same place about a week later.

Mr. A. T. Urquhart reports that in New Zealand earthworms ascend trees in the night or in damp mornings. The English earthworm is a very poor climber.

According to M. Gustav Cellerier ("Astronomische Nachrichter") the nucleus of the comet 1881 behaved optically like a gas. Its power of refraction at a distance of 102,000 kilometres from the nucleus = 0·0000093. Its spectrum has most resemblance to that of a hydrocarbon, especially to olefiant gas. Should such a gas become mixed with our atmosphere the consequence would doubtless be an explosion.

M. Guimaraes ("Comptes Rendus") shows that when coffee is ingested in moderate doses, in the course of a few days the activity of nutrition becomes greater, coincident with a marked augmentation of the pressure of the blood, acceleration of the movement of the heart, and of respiration, with a slight increase of rectal temperature and of the excitability of the nervous centres.

According to M. A. Robin ("Comptes Rendus") the fœtal envelopes of the Phyllostomidæ approach those of the Rodents, from which they differ merely by the absence of a terminal sinus, whilst those of the other *Cheiroptera* are nearer to the Primates.

The "Saturday Review" asks whether "literary study does not now in the lower ranks promote that vice of inobservance which it certainly promoted in the higher ranks a century or two ago?"

The French Academy of Sciences have lately proceeded to the election of a Foreign Associate, *vice* Prof. Wœhler, deceased. Prof. Bunsen obtained 30 votes; Van Beneden, 7; Nordenskiöld, 4; Prof. Adams, 1; and Sir Jos. Hooker, 1. The fact that Prof. Van Beneden stood second on the poll shows what influence the Old Natural History still retains among French official *savants*.

Dr. F. L. Oswald ("Popular Science Monthly"), in an able article on the "Curiosities of Superstition," hints that the dogma of metempsychosis is possibly nothing but a dimly expressed anticipation of the Evolution theory.

M. G. Colin, in a memoir presented to the Academy of Sciences, establishes that microbia are wanting in no part of the respiratory and digestive organs. Under normal conditions they

do not impart any virulent quality to the fluids which they inhabit.

M. G. Dupetit ("Comptes Rendus") shows that the edible mushrooms, such as *Boletus edulis* and *Agaricus campestris*, contain in their raw state a juice which proves fatal if injected below the skin of small animals. This poison is destroyed by a temperature of 212° F., and is probably one of the soluble ferments.

The Society for the Advancement of Medicine by Research is said to have "assumed a position of the utmost influence," to include in its ranks "every British biologist of note, lay as well as medical," and to be "receiving very liberal support, moral as well as pecuniary." It is singular that so little should be heard of a Society which has undertaken so important a work, and which is in so prosperous a condition.

M. Planchud ("Comptes Rendus") shows that certain Algæ have a power of reducing sulphates, which is not possessed by lifeless organic matter. He considers that the deposits of metallic sulphides and of free sulphur probably owe their origin to similar microbia.

MM. Gayon and Dupetit, at the same meeting of the Academy of Sciences, gave an account of a class of microbia which reduce alkaline nitrates present in the soil to nitrites.

Dr. C. C. Abbott considers that prior to the advent of the so-called Red Indians the eastern states of North America were inhabited by a people much resembling the Esquimaux.

Ch. A. Vogler states that the proportion of oxygen in the atmosphere fluctuates in accordance with the barometric pressure, the maximum in each being coincident.

M. Barille ("Recueil de Medecine Militaire"), in examining the blood of a horse which had died of rabies, found in the blood a prodigious number of bacteria. The white globules were abnormally numerous, and there were likewise oval corpuscles not present in normal blood, and having all the characters of a *Micrococcus*.

In various quarters we meet with notices of singular cures of diseases, said to be effected by "the prayer of faith," at an establishment in the north of London known as "Bethshan." As medical men take no part in the process we should like to know who diagnoses the various diseases? Hysteria is known to simulate paralysis, lameness, &c.

We learn with no small pleasure that the new American journal, "Science," will admit no advertisements "to which any reasonable objection can be made by scientific men," the

Editors having power of rejection. Hence we presume announcements of proprietary medicines and quackery in general will be excluded. We regret that all scientific organs in England do not adopt so highminded a policy.

We learn that Prof. Owen is in a very critical state of health.

The memorial to the late Prof. Sir C. Wyville Thomson has taken the form of a bust, to be set up in the University Hall of Edinburgh, and a painted window in St. Michael's church, Linlithgow.

The "Medical Press and Circular" predicts that we shall doubtless have murder by electricity before long, followed up by a verdict of "Death by the visitation of God."

Dr. Xaver Landerer, of Athens, maintains that the narcotic honey of Armenia, the effects of which were known as far back as the days of Xenophon, is obtained from the poppies cultivated in that country for the production of opium.

We read in "Light" for January 27th that a Dr. Planat suspends horizontally from the centre of an inverted bell-glass, by a thread of unspun silk, a piece of thin brass wire with its ends beaten out to foil. "The neuric force passing from the pointed fingers through the bell-glass, directed to either end of the wire and moved laterally, puts it in motion."

Unless our memory deceives us similar phenomena were occasionally reported in the earlier part of the present century, but could not be verified on critical examination. It is further stated in "Light" "that the late Mr. Wallington, a potent mesmeriser, assured me that a new knife, worn in his pocket for a short time, acquired the property of attracting needles."

Iron tools, &c., new and old, are so often found to be magnetic that the fact recorded is of no value unless both the knife and the needles had been previously examined and found to be non-magnetic.

"Science" has lost an enemy in the person of the deceased musician R. Wagner. He was committed to the "Anti-Vivisection" movement, and his admirers—blindly following a blind leader—helped to form the "public opinion" which some would have us respect. Perhaps had Wagner lived longer we should have had anti-vivisection operas as a companion-folly to the Edinburgh anti-vivisectionist prayer-meetings.